CHAPTER 2

2.0 ALTERNATIVES

2.1. Introduction

The selection of alternatives can involve the screening of both alternative project solutions to the transmission problem as well as alternative locations for any facilities those solutions require. These screenings involve gathering available data regarding the existing transmission system configuration, current and anticipated land uses, cultural features, natural resources, technical feasibility, other siting constraints, and economic factors including potential project costs.

A description of the various alternatives considered is provided in this chapter. Additional background information about transmission line and substation construction, operation, and maintenance is also provided and would be applicable regardless of the location of the transmission line. This chapter has the following seven major sections:

- Screening of Potential Solutions
- Comparison and Elimination of Potential Solutions From Further Study
- Description of Alternatives
- Project and Siting Alternatives
- Description of Construction, Operation, and Maintenance of the 500-kV Substation and 500- and 161-kV Transmission Lines
- Identification of the Preferred Alternative, Substation Site and Transmission Line Routes
- Mitigation Measures

This chapter describes all of the alternatives explored and provides a detailed description of the necessary steps in constructing a transmission line and substation.

2.2. Screening of Potential Solutions

The greater study area for the proposed project included Rutherford and Williamson counties and southeast Davidson County (Figure 1-1). Metropolitan areas include Brentwood, Franklin, Murfreesboro, and Smyrna. Transmission line upgrades potentially could also affect existing ROWs in Bedford, Coffee, Franklin, Moore, Maury, Sumner, and Wilson counties.

TVA studied the Middle Tennessee electrical load and capacity problems, and a number of options for correcting the problem were considered. Those that did not substantially address the need were eliminated, leaving three potential solutions that technically met the power supply needs of the system. These are identified as the Brentwood, Pinhook, and Rutherford solutions. Additionally, TVA looked at whether it would be possible to address the area needs through load management and conservation methods. These four potential solutions are described here in more detail.

2.2.1. New Brentwood 500-kV Substation and Transmission Line Upgrades

This alternative solution would consist of the construction and operation of a new 500-kV substation in northeast Williamson County near Brentwood and the upgrade of about 126 miles of existing 161-kV transmission lines.

The new substation would require a tract of land 50 to 70 acres in size to accommodate the substation and 500-kV and 161-kV transmission line connections. Few suitable undeveloped tracts of land occur in northeast Williamson County, and the most likely location is an undeveloped 264-acre farm east of State Route (SR) 252 (Wilson Pike) and south of Crockett Road (Figure 2-1). Based on the shape and topography of this tract, it could accommodate a 60+ acre substation in its southwest corner. This portion of the tract is close to TVA's Pinhook-Davidson 500-kV Transmission Line and East Franklin-Radnor Nos. 1 and 2 161-kV Transmission Lines, which would be connected to the substation. No additional transmission line easements would be required to connect these transmission lines to the substation. Other portions of the tract are less suitable as a substation site.

The existing transmission lines that would be upgraded are located in Davidson, Rutherford, Williamson, Sumner, Coffee, Franklin, and Bedford counties. Approximately 9 miles of transmission lines would be rebuilt by removal and replacement of structures (i.e., poles or towers), insulators, and conductors (wires), and 66 miles of transmission lines would be reconductored. This involves replacing the conductors with new higher capacity conductors. About 50 miles of transmission lines would be uprated to allow safe operation at higher temperatures and corresponding greater amount of sagging of the conductors that result from carrying a greater electrical load. Uprating typically involves adjusting the tension on the conductors and may also involve adding extensions to structures to increase the clearance between conductors and the ground.

This alternative solution has an advantage over the others in having somewhat lower capital costs (8.4 percent less than the Rutherford alternative solution and 2.9 percent less than the Pinhook alternative solution). Capital costs are defined as being the total project costs including material, land and land rights, labor, overheads and interest.

The total or overall project cost is defined as the cost of line losses which are affected by the distance between energy source (in this case the 500-kV substation) and end use, the voltage at which the energy is transmitted, and the size of conductor. This cost also includes additional future system upgrades which are expected to be needed within the 30-year project life to meet the needs identified.

When the overall project costs for the Brentwood alternative solution are considered, including the cost of power losses during transmission, this alternative solution ranks second, with a cost of about $3 million more than the Rutherford alternative solution. Another disadvantage of this alternative solution is that the potential substation site is completely surrounded by residential development, which would make the future connection of new transmission lines to the substation very expensive and disruptive of nearby land uses. The blasting of bedrock, which would likely be necessary to construct the substation, would also likely impact nearby residences.

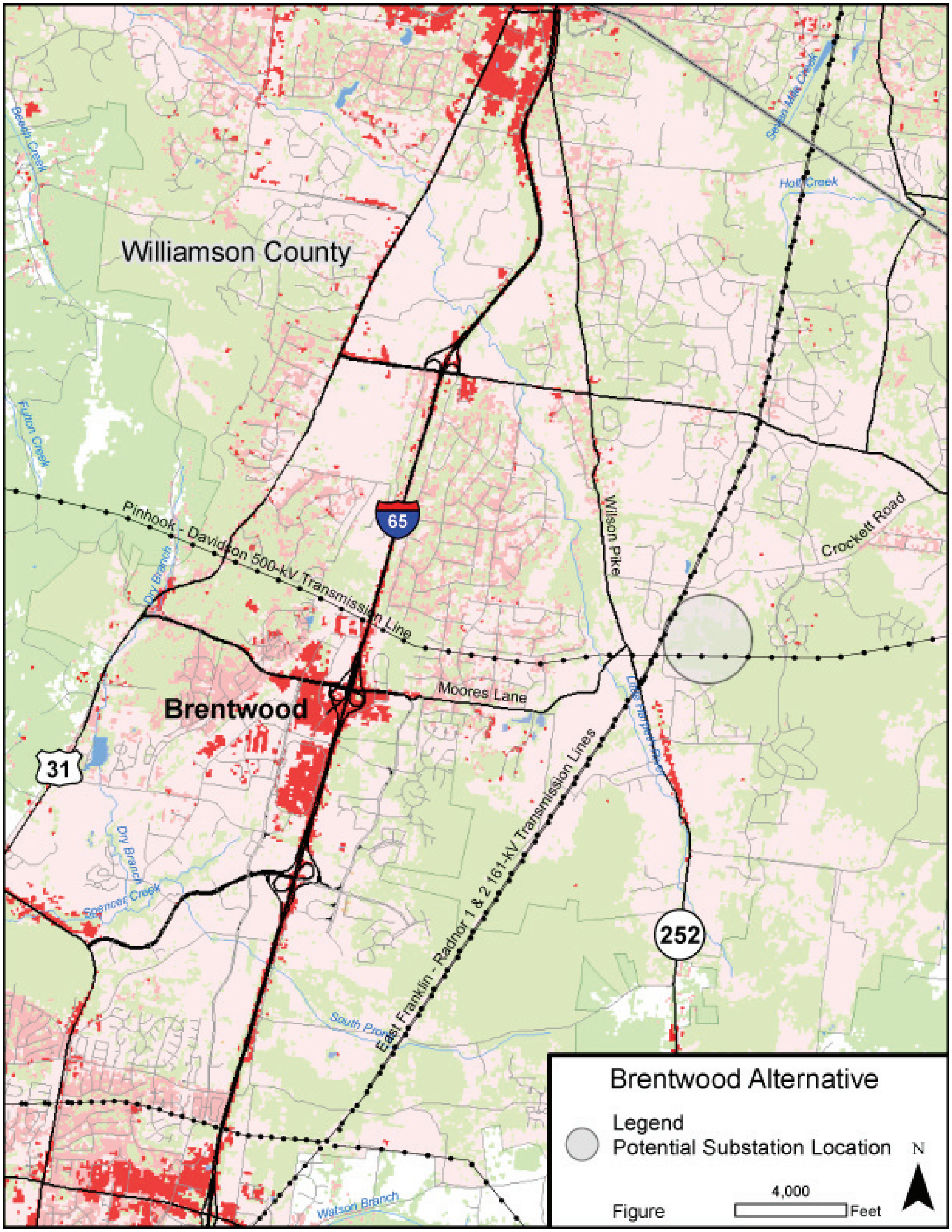

Figure 2-1. Location of the Potential Brentwood 500-kV Substation

The transmission lines to be upgraded as part of this alternative solution are critical components of the TVA transmission system and the number of lines that can be taken out of service simultaneously for upgrading is very limited. The time period during which lines can be taken out of service is also limited to the spring and fall when demand on the TVA system is typically lower than in the summer and winter. The sequence of line outages and the combinations of lines that can be out of service simultaneously are also important constraints. Because of these constraints, the transmission line upgrade work would extend from 2008 into 2011. With the overloading problems predicted to occur by 2010, the 2011 completion date increases the risk of service disruptions and degradation of reliability.

2.2.2. Pinhook 500-kV Substation Expansion and Associated Transmission Line Upgrades

This alternative solution would expand the existing Pinhook 500-kV Substation in southeast Davidson County and upgrade about 134 miles of existing 161-kV transmission lines.

The Pinhook Substation is located near the intersection of Old Hickory Boulevard and U.S. Highway (US) 41/Murfreesboro Road (Figure 2-2). It would be expanded by adding a second 500-kV transformer bank on the east side of the existing substation facilities. This expansion would require the clearing and grading of 2 to 3 acres of land presently owned by TVA. A large amount of blasting of limestone bedrock would be required to prepare the expansion site for installing transformer foundations.

The transmission lines to be upgraded are located in Davidson, Rutherford, Williamson, Sumner, Wilson, Franklin, and Bedford counties. Approximately 92 miles of transmission line would be reconductored, and 42 miles of transmission line would be uprated.

The capital costs of this alternative solution would be about 3 percent more than the Brentwood alternative solution and 6 percent less than the Rutherford alternative solution. The overall project costs, however, are about $20 million more than the Rutherford and $17 million more than the Brentwood alternative solutions. Transmission line losses make up a large proportion of these cost differences and are considerably higher for Pinhook than for the other alternative solutions. Another disadvantage in expanding the Pinhook Substation is the effects of the required blasting on existing substation components. Sensitive control equipment in the existing transformer bank could be damaged, resulting in an outage of the substation and connecting transmission lines.

As with the Brentwood Substation alternative solution, the transmission lines to be upgraded are critical components of the TVA transmission system and the number of lines that can be taken out of service simultaneously for upgrading is very limited. The time period during which lines can be taken out of service is also limited to the spring and fall. The sequence of line outages and the combinations of lines that can be out of service simultaneously are also important constraints. Because of these constraints, the transmission line upgrade work would extend from 2008 into 2012. With the overloading problems predicted to occur by 2010, the 2012 completion date increases the risk of service disruptions and degradation of reliability.

2.2.3. New Rutherford 500-kV Substation and Associated Transmission Lines

This alternative solution would consist of the construction and operation of a new 500-kV substation in southwest Rutherford County, a new 25- to 30-mile 500-kV transmission line, and three 161-kV transmission lines totaling about 23 miles in length.

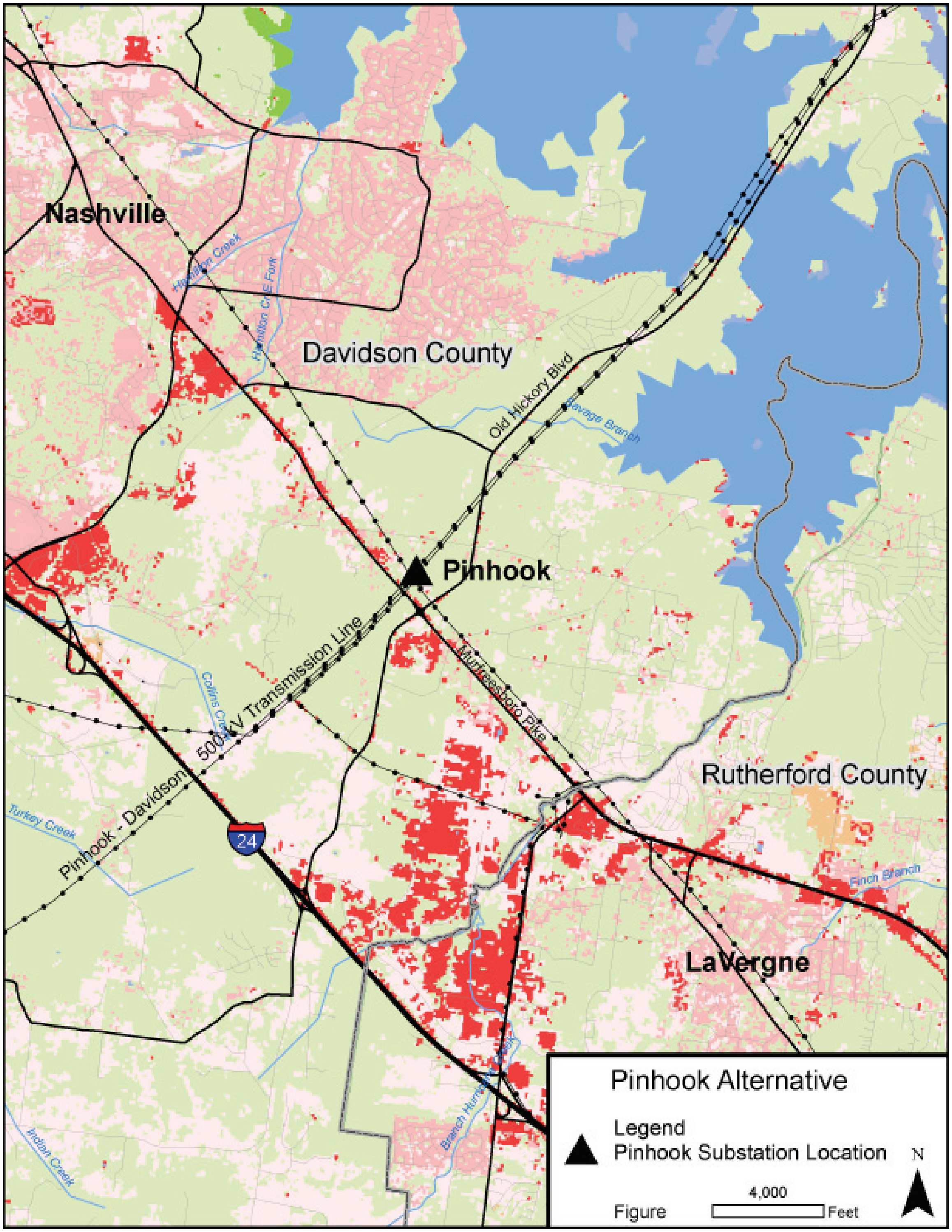

Figure 2-2. Location of TVA's Existing Pinhook 500-kV Substation

The new substation would require 40 to 60 acres. Potential sites under consideration for the substation are located in two distinct areas and shown in Figures 2-3 and 2-4. The northern area consists of about 310 acres in the Patterson Community along Patterson Road about 2 miles east of US 41 Alternate Highway (A)/31A. The area is presently undeveloped, rolling agricultural land with many rock outcrops. It is located about a mile north of TVA's vacant Hartsville-Maury 500-kV Transmission Line ROW (see below) and about a mile south of TVA's Murfreesboro-Triune-East Franklin Transmission Line. The likely location of the substation in this area would be determined after additional environmental and engineering studies are completed.

The second potential substation area consists of about 750 acres about 2 miles northeast of Eagleville (Figures 2-3 and 2-4). The area is about 1.5 miles east of US 41A and bounded on the north by Rocky Glade Road and on the south by the Harpeth River/Concord Creek. It is presently undeveloped, flat agricultural land with few visible rock outcrops. The area is about 1.5 miles south of TVA's vacant Hartsville-Maury 500-kV Transmission Line ROW land and about 5 miles south of TVA's Murfreesboro-Triune-East Franklin 161-kV Transmission Line. One or more likely locations of the substation in this southern area would be determined after additional environmental and engineering studies are completed.

The proposed 500-kV transmission line would extend from TVA's existing Maury 500-kV Substation, located in Maury County a short distance north of Columbia, northeast through the southeast corner of Williamson County to the new 500-kV substation in Rutherford County (Figure 2-3). It would be built on ROW that TVA purchased in the 1970s to construct the Hartsville-Maury 500-kV Transmission Line connecting TVA's Hartsville Nuclear Plant in Trousdale County and the Maury 500-kV Substation. TVA stopped construction of the Hartsville Nuclear Plant in the 1980s, and this transmission line was never completed. The portion of the ROW under consideration here has remained in TVA ownership and most of it was never cleared. Of the 27 miles of vacant, TVA-owned ROW, approximately 8 miles have been used for short, 161-kV transmission line connections. These transmission lines were designed to allow for the construction of a future 500-kV transmission line without acquiring additional ROW.

This proposed 500-kV transmission line section would be called the Rutherford-Maury 500-kV Transmission Line, but for the purposes of this document, this transmission line will be referred to as the proposed Maury 500-kV Transmission Line. A section of the transmission line would parallel the proposed Rutherford-Christiana 161-kV Transmission Line as they both approach the proposed Rutherford 500-kV Substation. To avoid repetition of the environmental evaluation of this section of ROW, for purposes of this document these evaluations have been included in the Affected Environment and Environmental Consequences descriptions of the Rutherford-Christiana 161-kV Transmission Line.

One of the proposed 161-kV transmission lines would run from the new 500-kV substation northward to MTEMC's existing Almaville 161-kV Substation located near SR 102 west-northwest of Murfreesboro (Figure 2-4). This 9-mile-long line would be built on 6 miles of vacant, TVA-owned ROW and 3 miles of new ROW. This proposed 161-kV transmission line section would be called the Rutherford-Almaville 161-kV Transmission Line, but for the purposes of this document, this transmission line will be referred to as the proposed Almaville 161-kV Transmission Line.

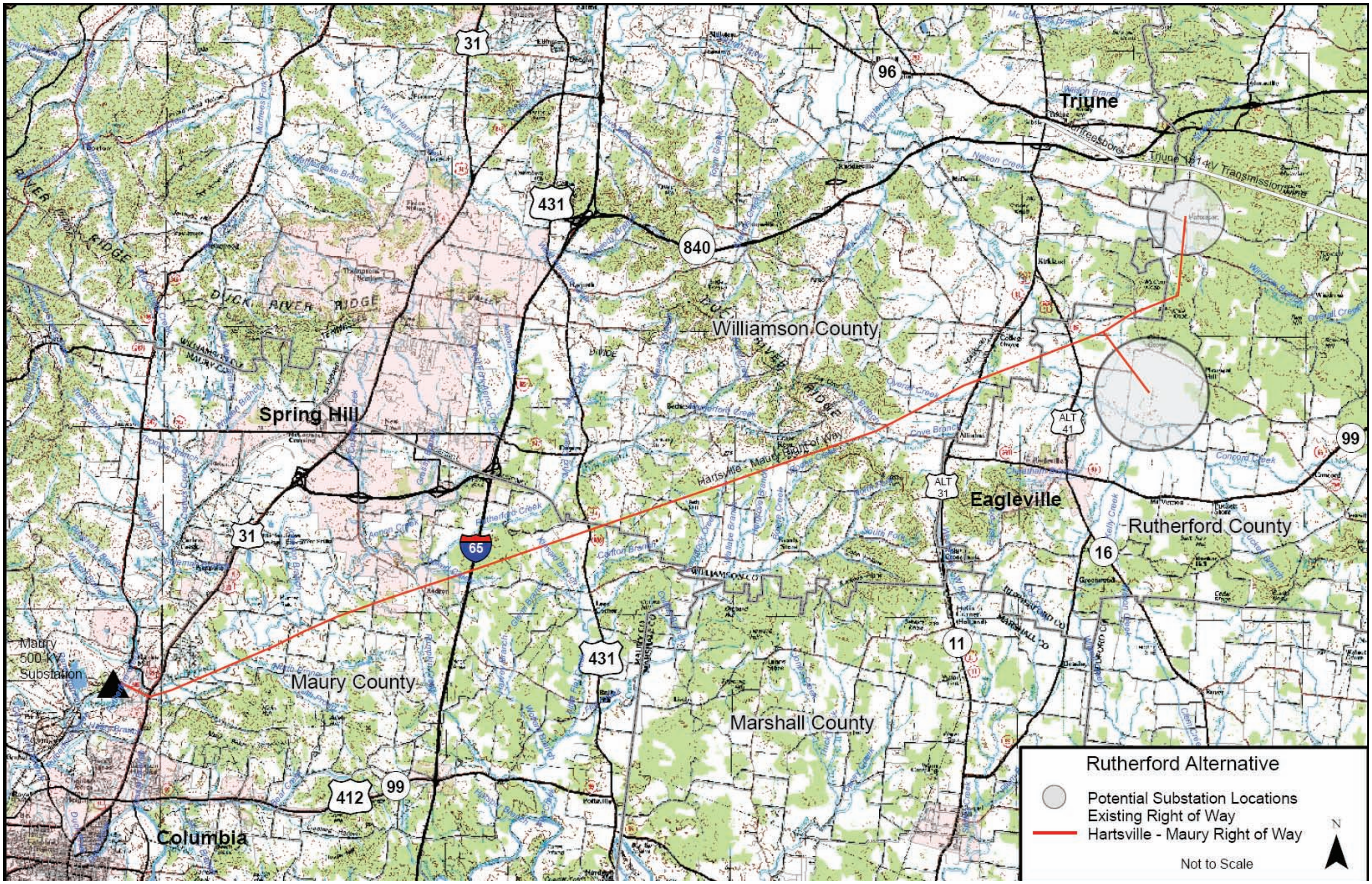

Figure 2-3. Location of Potential Rutherford 500-kV Substation Site and the Proposed 500-kV Transmission Line on the Vacant, TVA-Owned Hartsville-Maury Transmission Line Right-of-Way

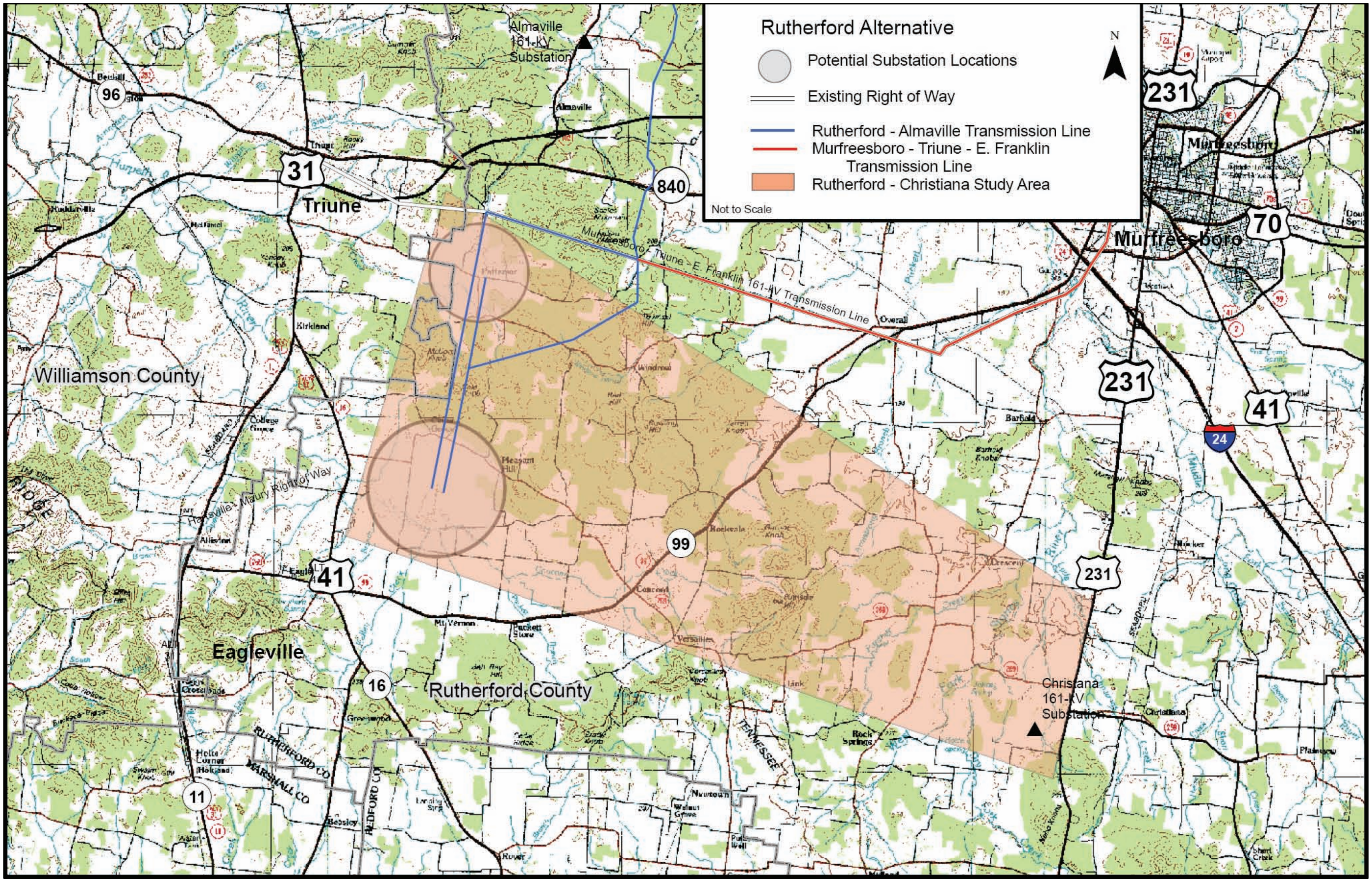

Figure 2-4. Potential Locations of the Rutherford 500-kV Substation, Hartsville-Maury Right-of-Way, Rutherford-Almaville Right-of-Way, the Proposed Transmission Line Connecting the Rutherford Substation to the Murfreesboro-Triune-East Franklin 161-kV Transmission Line, and the Study Area for the Proposed Rutherford-Christiana 161-kV Transmission Line

A section of the Almaville 161-kV Transmission Line would parallel the proposed connection between the proposed Rutherford 500-kV Substation and TVA's Murfreesboro-Triune-East Franklin 161-kV Transmission Line. To avoid repetition of the environmental evaluation of this section of ROW, for purposes of this document these evaluations have been included in the Affected Environment and Environmental Consequences descriptions of the Rutherford-Almaville 161-kV Transmission Line.

The second proposed 161-kV transmission line would be a double-circuit transmission line about 15 miles long built on new ROW 100 feet wide between the new 500-kV substation and MTEMC's existing Christiana 161-kV Substation located near the junction of US 231 and SR 260 south of Murfreesboro. The study area for this proposed Christiana Transmission Line is shown in Figure 2-4. This proposed 161-kV transmission line section would be called the Christiana 161-kV Transmission Line, but for the purposes of this document, this transmission line will be referred to as the proposed Christiana 161-kV Transmission Line.

The third proposed 161-kV transmission line would be a 3-mile-long line connecting the Murfreesboro-Triune-East Franklin 161-kV Transmission Line to the new 500-kV substation. Potential routes for this line are shown in Figure 2-4. This proposed 161-kV transmission line section would be called the Murfreesboro-Triune-East Franklin 161-kV Transmission Line loop to the Rutherford Substation, but for the purposes of this document, this transmission line will be referred to as the proposed Murfreesboro-Triune-East Franklin 161-kV Transmission Line connection. This 3-mile section would be parallel to a new transmission line connecting the new Rutherford Substation to TVA's vacant Almaville 161-kV Transmission Line ROW. Therefore, for purposes of this document, the evaluation of this section of transmission line is within the sections describing the proposed Almaville 161-kV Transmission Line.

The capital cost of the Rutherford alternative solution would be higher than either of the other two alternative solutions. Its total overall project cost, however, would be about $3 million less than the Brentwood and $20 million less than the Pinhook alternative solutions because of its greatly reduced transmission line losses. The Rutherford alternative solution would involve the most construction on greenfield sites, and thus the environmental impacts to some resources would be greater than those of the other alternative solutions. The Rutherford alternative solution, however, would not require the extended transmission line outages associated with the other alternative solutions and could be completed by the target date of 2010.

2.2.4. Load Management/Conservation

A major objective of this project is to maintain transmission system reliability by providing adequate electrical capacity. Reliability is related to system loads as well as system configuration and external factors such as weather, catastrophic events, and events on adjoining systems. In addition, the proposed project would address the present risk of maintaining the current level of service; this risk would increase as system loads increase in the future.

The risk for maintaining current levels of service to the greater Middle Tennessee area is partially load dependent and therefore could be addressed by load reduction. TVA currently operates energy conservation programs that TVA and distributors cooperatively promote and expand. These initiatives include *energy right*® installations and the Direct Load Control program (Appendix C). However, under present conditions, it would be necessary to decrease current peak loads by at least 800 megawatts (MW) to maintain acceptable voltage levels. A 2002 study conducted by Pacific Energy Associates for TVA assessed a number of demand-side management options (Gordon et al. 2002). This study showed that the maximum peak load reduction achievable within a two-year period, using a number of demand-side management options, was expected to be about 187 MW throughout the TVA system. Achieving an on-peak reduction of 800 MW in Middle Tennessee through demand-side management is not feasible.

2.3. Comparison and Elimination of Potential Solutions From Further Study

Following is a summary of the advantages and disadvantages of each of the potential solutions considered:

2.3.1. New Brentwood Substation Solution

- Lowest capital costs of the solutions involving substation construction or expansion but ranks second for overall costs
- New substation on undeveloped site surrounded by residential development
- Due to surrounding residential development, limited ability to construct future transmission line connections to substation
- No new transmission lines proposed, but extensive upgrade work on existing lines
- Due to restrictions on when existing transmission lines can be taken out of service for upgrades, the 2010 in-service date is not achievable

2.3.2. Pinhook Substation Expansion Solution

- Second-lowest capital costs of the solutions involving substation construction or expansion and highest overall costs
- No new property acquisition
- Blasting for site preparation could damage existing substation equipment
- No new transmission lines proposed but extensive upgrade work on existing lines
- Due to restrictions on when existing transmission lines can be taken out of service for upgrades, the 2010 in-service date is not achievable

2.3.3. New Rutherford Substation Solution

- Highest capital costs of the potential solutions and lowest overall costs of the solutions involving substation construction or expansion
- New substation on undeveloped site in rural area
- Up to 53 miles of new transmission lines, with about 37 miles on ROW owned by TVA
- Most of ROW owned by TVA is presently vacant
- Little to no upgrade work on existing lines
- Meeting 2010 in-service date appears achievable

2.3.4. Load Management/Conservation as a Solution

- No new property acquisition
- No new substations or transmission lines or upgrades
- Potential reduction of less than 200 MW achieved out of the 800 MW reduction that is needed
- System reliability would not be increased

- Current level of service would continue to be at risk and would increase as load levels increase
- The system load would exceed capacity by 2010

Conservation and load management would not fully address the system capacity and reliability issues that are an objective of the proposed action. These risks can only be decreased by addition of another high capacity transmission line in the area. The load management/conservation alternative was eliminated from further consideration.

Based on these comparison factors, especially the overall costs of the new solutions involving substation construction or expansion and the ability to meet the earliest possible in-service date (2010), TVA eliminated the Brentwood and Pinhook solutions from further consideration. The Rutherford solution was then identified as the most viable solution to meet the growing power needs in the project area.

2.4. Description of Alternatives

2.4.1. Alternative 1 – Do Not Build Additional Transmission Facilities (No Action)

Under this alternative, TVA would choose not to address the forecast high-voltage transmission capacity problem by implementing any of the potential solutions identified above. The TVA transmission system in Rutherford, Williamson, and Maury counties would continue to operate with a high-risk level of interruption in certain situations. This risk would likely increase over time as the electrical loads in the area continue to grow from ongoing and planned development. TVA has determined that this alternative would not address the capacity or reliability concerns in TVA's Middle Tennessee power service area.

2.4.2. Alternative 2 –Construct the Rutherford 500-kV Substation, 500-kV Transmission Line, and 161-kV Transmission Lines (Action)

As previously described in Section 2.2.3, this alternative would consist of the construction and operation of a new 500-kV substation in southwest Rutherford County, a new 27-mile 500-kV transmission line, and three 161-kV transmission lines totaling about 24 miles in length.

The new substation would require about 53 acres (Figures 2-3 and 2-4). Most of the proposed 500-kV transmission line would be built on vacant, TVA-owned ROW extending from TVA's existing Maury 500-kV Substation to the new 500-kV substation in Rutherford County (Figure 2-3).

TVA also proposes to build two 161-kV transmission lines between the new Rutherford Substation and the nearby existing Almaville and Christiana 161-kV substations (Figure 2-4). The Almaville 161-kV Transmission Line would be built on approximately 6 miles of vacant, TVA-owned, 100-foot-wide ROW. In addition, TVA would build approximately 3 miles of new 161-kV transmission line with an 85-foot-wide ROW from the Rutherford 500-kV Substation to the Almaville Transmission Line that would partially parallel the existing Murfreesboro-Triune-East Franklin 161-kV Transmission Line. The Rutherford-Christiana 161-kV Transmission Line would be built on approximately 15 miles of new 100-foot-wide ROW.

Additional activities would be required within the existing substation switchyards, including the construction of new line breaker bays and the installation of breakers and their associated control and communication equipment.

This alternative would meet the growing power needs in the Middle Tennessee power service area by providing a new higher capacity source of power to accommodate the area's current and anticipated growth of electric load. It would substantially reduce the risk of service disruptions in the area.

2.5. Project and Siting Alternatives

The process of siting the Rutherford Substation and associated transmission line connections followed the basic steps used by TVA:

- Define the study area.
- Collect data to minimize potential impacts to cultural and natural features.
- Determine potential substation options.
- Develop associated transmission line connection routes.
- Gather public input.
- Incorporate public input into the final identification of the preferred substation location and associated transmission line connections.

2.5.1. Definition of Study Area

Based on the identification of the Rutherford solution as the most viable choice following the public scoping meeting, a study area was developed to utilize TVA's vacant ROW and accommodate the proposed 500-kV substation site on a nearby 50-60 acre tract. This study area also took into account the need for multiple transmission line segments that would eventually yield preferred transmission line routes between a new 500-kV substation and existing 161-kV substations.

The geographic area studied is approximately 715 square miles and included Rutherford and parts of Williamson, Maury, and Davidson counties (see Figure 1-3). The western boundary of the study area is US 31 beginning at the north city limits of Columbia and extending north to its intersection with SR 254. The northern boundary is SR 254 eastward to its intersection with US 41. The eastern boundary follows US 41 to the southeast to its intersection with US 231. The east boundary then follows US 231 southward to a point 1 mile south of Christiana. The southern boundary follows an imaginary line westward back to the point 1 mile north of Columbia.

This is a largely rural area rapidly undergoing change. The densely developed areas are Franklin, Brentwood, Smyrna, Spring Hill, Thompson's Station, Christiana, Nolensville, Almaville, and Murfreesboro. Some of the major streams in the study area are West Fork of the Stones River, Harpeth River, Little Harpeth River, Panther Creek, Duck River, and Rutherford Creek. The rural areas are typically wooded, rolling and hilly land, with abundant rock outcrops, cave systems, and sinkholes. The open lands are mainly pasture for horses and cattle. There are numerous small farms devoted to raising goats. These rural areas are quickly being converted to residential use by developers. Major highways in the area are US 231, 41, 41A, 31A, 31, 431, Interstate Highways (I-) 65 and 24, SRs 840, 99, 96, and Saturn Parkway.

2.5.2. Collect Data

Geographic data such as topography, land use, transportation, environmental features, cultural resources, near-term future development, and land conservation information were collected for the study area. This data gathering included the acquisition of up-to-date aerial color orthophotography. Analysis of the data was aided by using the Geographic Information System (GIS). This system allowed the multitude of factors of the study area to be examined simultaneously to develop and evaluate numerous options and scenarios to determine the sites that would best meet project needs, including avoiding or reducing potential environmental impacts.

Maps were created to show regional opportunities and constraints clearly. Sources included 1 inch = 500 feet aerial photography, county tax maps/property boundaries, U.S. Geological Survey (USGS) digital line graphs, digital elevation models, National Wetlands Inventory, and cultural resource data, among others. Aerial photography was interpreted to obtain land use and land cover data, such as forests, agriculture, wetlands, houses, barns, commercial and industrial buildings, churches, and cemeteries. Data were analyzed both manually and with GIS. Manual calculations from aerial photographs, tax maps, and other sources included the number of road crossings, stream crossings, and property parcels.

2.5.3. Establish and Apply Siting Criteria

TVA utilizes a set of evaluation criteria that represent opportunities and constraints for development of substation sites and transmission line routes. The criteria are oriented toward factors such as existing land use, ownership patterns, environmental features, cultural resources, and visual quality. Cost is also an important factor, with engineering considerations and ROW acquisition costs being the most important economic elements. Constraints influence, but do not dictate, siting outcomes.

2.5.3.1. Substation Site Criteria

The substation siting criteria include engineering and construction feasibility, environmental effects, land use compatibility, and feasibility of transmission line connections.

- *Engineering and Construction*: The suitability of the size of the site itself for grading, fencing, and security needs, along with evidence that the site is not in a 100-year floodplain, which would require filling to a final grade above flood level. These concerns also require locations near public roads to minimize construction of a lengthy access drive, development of a safe driveway connection with good sight distance in each direction, and ease of delivery of extremely large electrical equipment by heavy equipment hauling contractors. Also to be considered are good site drainage, soils suitable for grading and foundation construction, minimal tree clearing needs, and availability of off-site electrical service and communications sources.
- *Environmental Factors:* The presence of threatened and endangered plant and animal species including locations around the perimeter of the site that would have to be crossed by future transmission line routes. Other factors are historic structures or sites on or adjacent to the site; presence or proximity to prime farmland; and wetlands, streams, ponds, and other aquatic features crossing or touching the site.
- *Land Use Compatibility Factors:* The number of individual property tracts that make up the site; the current land uses on and near the site; number of houses on and near the site; and the level of visual impact to the surrounding area homes and traveling public.
- *Transmission Line Connections*: This involves transmission line routing criteria as described below in Section 2.5.3.3, some of which are identical to those listed above for substations, i.e., engineering and construction feasibility, environmental effects, and land use compatibility. This primarily involves the attempted avoidance of features and areas that are generally incompatible with transmission lines while identifying other areas with more compatible land uses, thereby, reducing impacts. Engineering and construction constraints include overall length and feasibility for construction access to the line route from existing roads. The areas that are more compatible with a line route are linear

features such as long property lines that are aligned with the general direction of the route itself or other “edges” between different land uses.

Due to the rapid development of the study area, the use of existing ROWs when determining a potential 500-kV substation site was considered an important siting opportunity. There are two existing, vacant ROWs in the study area on which TVA owns easements, giving it the rights to build and operate transmission lines, and that could be utilized for this project. One of these is the Hartsville-Maury 500-kV Transmission Line ROW described above in Section 2.2.3. The portion of this ROW between Murfreesboro and Columbia follows a vacant 100-foot-wide easement, which originally contained a 69-kV transmission line that TVA removed for use elsewhere during World War II. As part of the Hartsville-Maury project, TVA purchased additional easement rights during the 1970s that expanded much of this ROW to a width of 175 feet. TVA was in the final stages of purchasing the additional easement when the construction of Hartsville Nuclear Plant stopped. In order to construct the proposed 500-kV transmission line on this ROW, TVA would have to purchase easement rights on 10 tracts totaling 31 acres and extending 7,600 feet along the ROW.

A comparison study of the use of this vacant easement with obtaining a separate new route for a 500-kV transmission line from the Maury Substation to the Rutherford Substation was made early in the process. According to county tax maps, a new 175-foot-wide route located between the Maury Substation and potential Rutherford Substation sites would affect over 200 separate parcels of land. Other possible routes connecting to the Maury Substation running north or south of the existing ROW would cross areas similar in nature and in land uses. A 500-kV connection to another TVA substation would traverse highly congested areas in the Nashville metropolitan area or would be over twice as long as the Maury connection. These line routes would have added millions of dollars to the project cost without the likelihood of reducing impacts. For this reason, the 27-mile-long section of the vacant easement was identified as the proposed location for most of the proposed 500-kV transmission line.

A similar situation occurred regarding 6 miles of vacant 100-foot-wide easement initially bought by TVA in the 1990s for a future 161-kV transmission line to connect the Smyrna and Murfreesboro substations. When comparing the impacts of a slightly shorter route consisting of new easement to a longer route using 6 miles of existing easement with 3 miles of new easement parallel to an existing transmission line, the same conclusion was reached. A new line route would have increased the project cost without the likelihood of reducing impacts, and more individuals would have been affected. Therefore, this combination of existing and new easements was identified as the proposed location for the 161-kV transmission line connection between the MTEMC’s existing Almaville Substation and the proposed Rutherford 500-kV Substation.

2.5.3.2. Potential Substation Sites

Figure 2-5 shows four potential substation sites with possible transmission line routes for connecting the substation to the existing power system. These four sites were initially identified for study using the criteria described in Section 2.5.3.1 using the best available information that could be obtained. No on-site investigations had been made prior to the open house presenting the project alternatives to the public. These potential substation sites consisted of enough land of suitable topography to accommodate a substation requiring 60 to 70 acres. There were no visible bodies of water or creeks running through the sites. The sites were not too steep (requiring extensive grading) or covered in forest (requiring clearing and associated environmental impacts), and they were remote from heavily developed residential areas.

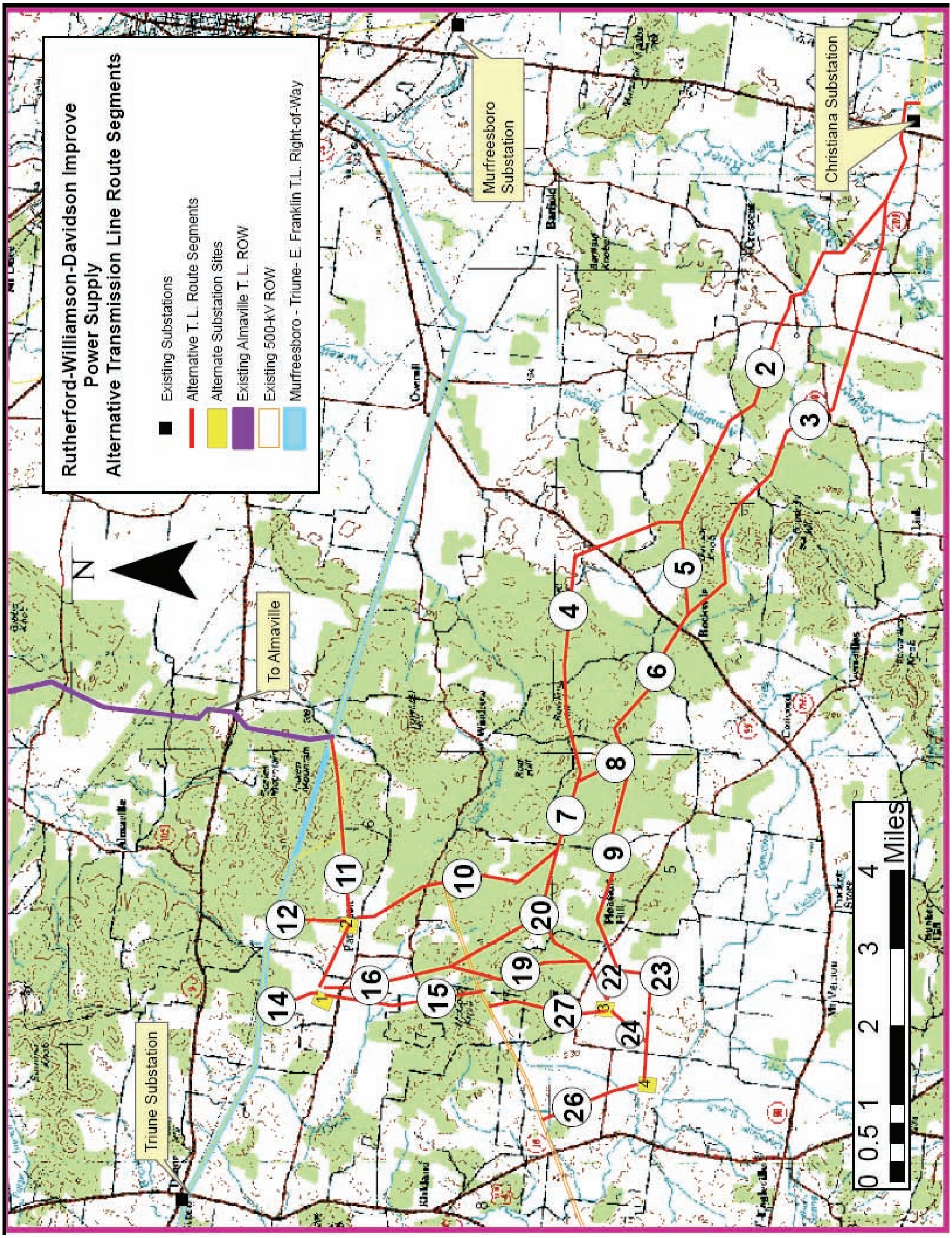

Figure 2-5. Alternate Substation Sites and Transmission Line Route Segments

Additionally, their proximity to existing TVA transmission lines and/or vacant easements appeared to offer opportunities for transmission line connections to the substation.

Site 1 is located on the north side of Patterson Road and about 3 miles east of US 41A/31A. The site contains two property parcels. The larger is a cultivated field, and the smaller parcel is a pasture field. The land just south of the site is being used for sod production, and that also appears to be true for Site 1. There are seven houses surrounding the site, and few trees occur on the site. Rehobeth Road is directly east of Site 1. This road is a direct link between SR 96 and Patterson Road. This site would require minimum new ROW for the Almaville Transmission Line connection and the loop of the Murfreesboro-Triune-East Franklin 161-kV Transmission Line. It would require about 2 miles of new, 425-foot-wide ROW for the 500-kV transmission line connection, which would have the double-circuit transmission line to the Christiana Substation underbuilt on its towers.

Site 2 is on the north side of and adjacent to Coleman Hill Road, which is an eastward continuation of Patterson Road that turns south a few hundred feet west of Site 2. It is about a mile east of Site 1. There is very sparse residential development near the site, which is very level and is used for pasture and hay production. Site 2 would require very little tree removal. The surrounding farms are similar to this site. Immediately north of Site 2 are the forested, undeveloped Indian Mountain and Scales Mountain. This site would result in the least new ROW required for the Almaville and Murfreesboro-Triune-East Franklin 161-kV transmission line connections. The new, 425-foot-wide ROW for the 500-kV transmission line connection with the Christiana 161-kV Transmission Line would be about 1.3 miles long.

Site 3 is on Rocky Glade Road about 2.2 miles east of US 41A in the Cedar Grove Community. The total area appears to be in pastureland with a single row of trees splitting the site in a north-south direction. Concord Creek is south of Site 3 and its broad 100-year floodplain extends to the south edge of this site. It is surrounded on the north and west sides with homes and barns that were built along Shoemaker Road and Rocky Glade Road. Site 3 is relatively flat and would require minimum grading. The new 425-foot-wide ROW to connect to the 500-kV easement would be about 1.5 miles long. The new ROW to connect to the northern 161-kV lines would be about 4.6 miles long.

Site 4 is a few hundred feet west of Shoemaker Road and 0.5 mile south of Rocky Glade Road. This total site is pasture and hayfield. It is primarily flat and would need minimum grading. It is bounded on the south by the 100-year floodplain of Concord Creek, on the west by US 41A, and on the east by Shoemaker Road. This site is northeast of the town of Eagleville.

As part of the substation site screening, potential routes for hauling heavy electrical equipment into each site were investigated, and there were no obvious issues identified. Each site was also compatible with a network of possible transmission line routes (described in more detail below) to connect the substation to TVA’s power grid. Based on these considerations and the site-specific details listed above, all four of these sites appear to be suitable for the construction and operation of a 500-kV substation.

2.5.3.3. Transmission Line Routing Criteria

Each of the transmission line route options was evaluated according to criteria relating to engineering, environmental, land use, and cultural concerns. Specific criteria are described below. For each category described, a higher score means a bigger constraint. For example, a greater number of streams crossed, a longer transmission line route length, or a greater number of historic resources affected would give a transmission line route option a worse score.

- *Engineering Criteria*: Total length of the transmission route, length of new ROW and rebuilt ROW, primary and secondary road crossings, pipeline and transmission line crossings, and total capital line cost
- *Environmental Criteria*: Slopes greater than 30 percent (steeper slopes mean more potential for erosion and potential water quality impacts), slopes between 20 and 30 percent, visual aesthetics, forested areas, open water crossings, sensitive stream (those supporting endangered or threatened species) crossings, perennial and intermittent stream crossings, wetlands, rare species habitat, natural area crossings, and wildlife management areas
- *Land Use Criteria*: The number of fragmented property parcels, schools, houses, commercial or industrial buildings, barns, and parkland crossings
- *Cultural Criteria*: Archaeological and historic sites, churches, and cemeteries

Scores for each of the route options were calculated by adding individual criterion values for each potential transmission line route. The resulting sum values were evaluated using standard statistical techniques and were assigned a ranking for each route in each subcategory (engineering, environmental, land use, and cultural).

A weighted score was produced for each transmission line route option in each subcategory. This made it possible to understand which routes would have the lowest and highest impacts on engineering, environmental, land use, and cultural resources. Finally, to determine total impacts, the scores from each category were combined for an overall score.

2.5.3.4. Transmission Line Route Evaluation and Identification

A series of topographic maps, computer generated constraint maps, and county tax maps with aerial photographic backgrounds were used to identify a network of possible routes for transmission lines connecting the existing MTEMC Christiana 161-kV Substation just east of US 231, the proposed 500-kV transmission line, and the four potential 500-kV substation sites. These potential transmission line routes were field verified, and property ownership was obtained along each centerline and in close vicinity to the left and right of each route.

The route segments between the existing 500-kV transmission line easement and the proposed substation sites would accommodate future 500-kV transmission line connections, if needed. Routes were also identified for the construction of the transmission line loop for the Murfreesboro–East Franklin 161-kV Transmission Line into the proposed Rutherford Substation and the 161-kV transmission line from the proposed Rutherford Substation to connect the existing MTEMC Almaville Substation.

Segments of each of these alternative routes were assigned numbers to allow a variety of combinations of connected segments to result in numerous possible routes for comparison and quantification of their possible impacts. The route segment numbering system begins at the Christiana Substation, since it was a fixed point that required the longest eventual transmission line to tie into any of the possible sites to the west. All the potential routes would cross US 231, SR 99, and the West Fork of the Stones River. Twenty-seven potential route segments and four substation sites were presented to the public on April 6, 2006 (Figure 2-5). Through various combinations of the potential route segments, a total of 60 transmission line route alternatives were possible between the Maury, Christiana, and Almaville substations and the proposed substation sites (Table 2-1).

Segment 1 begins at a tap point 1,200 feet east of the Christiana Substation in the existing double-circuit, 161-kV transmission line serving that station. The route then proceeds 1,000 feet north across a pasture, turns west, and crosses open land for 2,400 feet (crossing US 231 at an opening with no houses) to an angle point in another pasture field. At that point, the route turns slightly southwest, then eventually west for 4,500 feet across open fields. A subdivision is north of this route, and several homes along Walnut Grove Road are directly south of and parallel to this segment. Segment 1 is about 1.4 miles long and crosses entirely open fields. At the end of Segment 1, the route splits into two paths (Segments 2 and 3) across the West Fork of the Stones River and to just east of SR 99.

Table 2-1. Potential Transmission Line Routes to the Original Proposed Rutherford Substation Sites and Substation Site 2A, Utilizing the Proposed Transmission Line Segments 1 through 27

Route	Segments	Substation Site
1	1,2,4,7,10,12	2 and 2A
2	1,2,4,7,10,11,12	2 and 2A
3	1,2,5,6,7,8,10,12	2 and 2A
4	1,2,5,6,7,8,10,11,12	2 and 2A
5	1,3,6,7,8,10,12	2 and 2A
6	1,3,6,7,8,10,11,12	2 and 2A
7	1,2,4,7,14,15,16,17,18	1
8	1,2,4,7,11,14,15,16,17,18	1
9	1,2,4,7,14,16,17,18	1
10	1,2,4,7,11,13,14,16,17,18	1
11	1,2,5,6,7,8,14,15,16,17,18	1
12	1,2,5,6,7,8,11,14,15,16,17,18	1
13	1,2,5,6,7,8,14,16,17,18	1
14	1,2,5,6,7,8,11,14,16,17,18	1
15	1,3,6,7,8,14,15,16,17,18	1
16	1,3,6,7,8,11,14,15,16,17,18	1
17	1,3,6,7,8,14,16,17,18	1
18	1,3,6,7,8,11,13,14,16,17	1
19	1,2,4,7,14,15,18,20,21,27	3
20	1,2,4,7,14,15,18,20,21,27*	3
21	1,2,4,7,14,15,18,19,20,21	3
22	1,2,4,7,14,15,18,19,20,21*	3
23	1,2,5,6,7,8,14,15,18,19,20,21,27	3
24	1,2,5,6,7,8,14,15,18,19,20,21,27*	3
25	1,2,5,6,7,8,14,15,18,19,20,21	3
26	1,2,5,6,7,8,14,15,18,19,20,21*	3
27	1,3,6,7,8,14,15,18,20,21,27	3
28	1,3,6,7,8,14,15,18,20,21,27*	3
29	1,3,6,7,6,14,15,18,19,20,21	3
30	1,3,6,7,6,14,15,18,19,20,21*	3
31	1,2,5,6,9,14,15,21,22	3
32	1,2,5,6,9,14,15,21,22*	3
33	1,2,5,6,9,14,16,19,22	3

Route	Segments	Substation Site
34	1,2,5,6,9,14,16,19,22*	3
35	1,3,6,9,14,15,22,27	3
36	1,3,6,9,14,15,22,27*	3
37	1,3,6,9,14,16,19,21,22	3
38	1,3,6,9,14,16,19,21,22*	3
39	1,2,4,7,14,15,18,20,21,24,25,26	4
40	1,2,4,7,14,15,18,20,21,24,25,26*	4
41	1,2,4,7,14,15,18,20,21,24,25,26,27	4
42	1,2,4,7,14,15,18,20,21,24,25,26,27*	4
43	1,2,5,6,7,8,14,15,18,20,21,24,25,26	4
44	1,2,5,6,7,8,14,15,18,20,21,24,25,26*	4
45	1,2,5,6,7,8,14,15,18,20,21,24,25,26,27	4
46	1,2,5,6,7,8,14,15,18,20,21,24,25,26,27*	4
47	1,3,6,7,8,14,15,18,20,21,24,25,26	4
48	1,3,6,7,8,14,15,18,20,21,24,25,26*	4
49	1,3,6,7,8,14,15,18,20,21,24,25,26,27	4
50	1,3,6,7,8,14,15,20,21,24,25,27	4
51	1,2,5,6,9,14,15,23,25,26	4
52	1,2,5,6,9,14,15,23,25,26*	4
53	1,2,5,6,9,14,15,23,25,26,27	4
54	1,2,5,6,9,14,15,23,25,26,27*	4
55	1,3,6,9,14,15,23,25,26	4
56	1,3,6,9,14,15,23,25,26*	4
57	1,3,6,9,14,15,23,25,26,27	4
58	1,3,6,9,14,15,23,25,26,27*	4
59	1,3,6,9,23,25,26	4
60	1,3,6,9,19,21,23,24,25,26	4

*Different line grouping and structure combinations result in routes that duplicate the preceding route but with differing ROW widths

Segment 2 turns slightly more to the northwest to cross the floodplain of the river and spans the river just south of a bend about 1,900 feet south of Stones River Road. The route then turns north, crossing Stones River Road at an undeveloped spot, turns to a general northwest path, avoiding homes along Barfield Crescent Road, and crossing Midland Road and Whitus Road in open areas. It crosses north of and avoids Garrett Knob and two prominent hills to its east. This segment is about 5.1 miles long and crosses about 34 acres of forest. The remainder is open pastureland.

Segment 3 commences in a nearly western direction, crosses the West Fork of the Stones River 2,200 feet south of the alternate crossing point, continues westward across Midland Road, crosses a tributary stream of the West Fork, and turns northwest and crosses Panther Creek Road while avoiding scattered home sites in the vicinity. The route then turns slightly more westward, crosses Whitus Road about 1.2 highway miles south of the Segment 2 crossing, passes south of Garrett Knob, and terminates at a point slightly northeast of Rockvale. This segment is about 6.2 miles long. It crosses approximately 38 acres of forested land that would be removed from a 100-foot-wide easement.

Segment 4 begins at the west terminal of Segment 2 by proceeding in a north direction for 1,500 feet then turning to the north-northwest to avoid heavy residential development on each side of SR 99 and a steep hilly area to its east. After crossing the state highway, the route turns west to avoid Rockvale Middle and Elementary schools. It proceeds westward, avoiding a subdivision under development to its north and the cave opening of Snail Shell Cave further west and to its south. It terminates at a point 3,000 feet west of its crossing of Windrow Road. Segment 4 is 4.3 miles long. It crosses mostly forested areas and would require clearing 37 acres of forest.

Segment 5 is 6,000 feet in length and was chosen as a connection between the end points of Segments 2 and 3. It is directly north of Garrett Knob and crosses forested land for its complete length.

Segment 6 begins at the end points of Segments 3 and 5. It is 2.1 miles long, follows a northwest path, and crosses three busy roads, especially SR 99. It passes northeast of the community of Rockvale, avoids many homes along Old Jackson Ridge Road, and terminates just west of Windrow Road. This segment contains 20 acres of forest that would need to be cleared.

Segment 7 follows a straight-line route to the west for almost a mile, crossing mostly wooded areas and passing south of a rural cemetery at the end of Dyer Road. Eight acres of this segment is forested. At the west end of this segment, two segments lead to the four potential substation sites.

Segment 8 is a straight-line route that would connect the endpoint of Segment 6 to Segment 4. It is 3,600 feet long and forested.

Segment 9 begins at the western end of Segment 6. It follows a west path for 2.8 miles through mostly wooded parcels. It crosses Morgan Road and Rocky Glade Road at areas where homes have not yet been built. Several homes along these roads would have views of a transmission line along this segment. This segment would require clearing 26.5 acres of forest.

Segment 10 originates at the end of Segment 7 just west of Morgan Road. It heads northwest, then north, for a total of 1.6 miles, through wooded, undeveloped areas where it intersects the existing 500-kV transmission line easement. It continues on to the north for 1.2 miles to Substation Site 2. This 1.2-mile portion of the segment crosses wooded parcels. It crosses Patterson Road and Coleman Hill Road in areas of no houses. This 1.2-mile section would be over 400 feet in width to accommodate an initial and future 500-kV transmission line with underbuilt 161-kV transmission lines and for a future 161-kV transmission line to an undetermined location parallel to the 500-kV transmission lines.

Segment 11 is an alternative route to connect Substation Sites 1 and 2 to the south end of the existing 100-foot-wide, vacant easement to the Almaville Substation. Segment 11 is 100-foot-wide, 2.3 miles long and crosses a completely wooded area south of Indian Mountain. It could also accommodate the loop of the Murfreesboro-Triune-East Franklin Transmission Line into Site 2 or Site 1. It would require clearing about 28 acres of forest.

Segment 12 is 0.9 mile long and crosses mixed woods and pasture fields. It would accommodate the loop of the existing 161-kV transmission line and the extension of the Almaville Transmission Line into Site 2 with the remainder of the Almaville Transmission Line being constructed parallel to the existing Murfreesboro-Triune-East Franklin 161-kV

Transmission Line for 2.4 miles from the south terminus of the existing, vacant easement from the Almaville Substation. This segment could be up to 275 feet wide.

Segment 13 is a connecting link between Sites 1 and 2. It is 1 mile long, crosses open pasture fields, and requires a crossing of Rehobeth Road at a point 1,500 feet north of Patterson Road. This would allow a route to serve Site 2 made up of Segments 13 and 14 if needed. That would be an option if Segments 11 or 12 are not viable.

Segment 14 is a route for a loop connection to the Murfreesboro-Triune-East Franklin 161-kV Transmission Line. It would also accommodate the extension of the Almaville Transmission Line. The portion of the Almaville Transmission Line beyond this segment would require 3 miles of 87.5-foot-wide ROW, parallel to the existing 161-kV transmission line eastward to the south terminus of the existing, vacant easement from Almaville Substation. Approximately 38 acres of forest would be cleared.

Segments 15 and 16 are wide segments, each about 2 miles long. The final width of these segments would depend on how many transmission lines would occupy them, which would be determined by the final location of the substation. These two segments cross land partially wooded with some open areas containing scattered home sites. The area just south of Patterson Road is being used as a sod farm.

Segments 17 and 18 provide for the connection from the Christiana Substation that approaches on Segment 7 to Substation Site 1. These two segments combined are 2.1 miles long, and they cross forested, slightly rolling land. Slightly over 25 acres of forest would be cleared on these two segments.

Segment 19 extends southward from the south end of Segment 16 and crosses hilly, wooded parcels for the most part. Its south end enters a built-up residential area in Cedar Grove. It is 9,000 feet in length and would be occupied by the 161-kV transmission lines from the north that would be connected to Substation Site 3 or 4.

Segment 20 turns southwest from the west end of Segment 18 and provides a path for the double-circuit transmission line from the Christiana Substation. This 4,500-foot-long route traverses wooded parcels and crosses Hill Road in an undeveloped area and ends at the south point of Segment 19.

Segment 21 begins at the above point north of Rocky Glade Road, travels southwest for 3,000 feet, and terminates in the center of Substation Site 3. The final width of this segment would be determined by the number of 161-kV transmission lines built on it.

Segment 22 begins at the west end of Segment 9 and would continue the Christiana Transmission Line into Substation Site 3 or 4. It crosses a floodplain for 2,100 feet to the center of Site 3.

Segment 23 is an alternate path for Segment 22 if Site 4 were chosen. It would keep the Christiana Transmission Line out of the farming operation on Site 3 and stay entirely in the floodplain. It is 1.3 miles long.

Segment 24 is 3,500 feet long and follows the boundary of the floodplain. This segment would most likely accommodate all or part of the 161-kV transmission lines from the north and east into Substation Site 4 if it were chosen.

Segment 25, which is 3,000 feet long, crosses open, cultivated land and crosses Shoemaker Road 2,200 feet south of Rocky Glade Road. This segment could contain all the 161-kV transmission lines connecting into Substation Site 4.

Segment 26 begins at a point in the existing 500-kV easement 2,200 feet east of US 41A to provide a route for the 500-kV transmission line connection into Substation Site 4. It is 1.4 miles long and crosses open farmland, avoiding homes and buildings between the segment and US 41A, which lies to its west.

Segment 27 begins at a point in the 500-kV easement that is 2 miles east of US 41A. It proceeds south for 7,500 feet across mostly wooded land and terminates in the center of Substation Site 3. It crosses Cedar Glade Road just 500 feet east of a church building. About 14 acres of forest would be cleared on this segment if chosen. This segment would allow for a future 500-kV transmission line, if needed, along with a few 161-kV transmission lines from the north.

2.5.3.5. Identification of Preferred Transmission Line Route

After TVA identified the potential substation sites and transmission line route combinations, property owners whose property was touched by a potential site or crossed by or near a route segment were invited by letter to an open house hosted by TVA.

Information was presented in writing and verbally to attendees at the open house in Eagleville, Tennessee, on April 11, 2006. It was also provided to any interested members of the public through TVA's Web site or by request. This information included:

- A summary of the project.
- Maps of the study area with the potential substation sites and transmission line routes to serve them.
- A comment form.
- Information on where and how to provide comments.

Open house attendees were given the opportunity to look at a property tax map to see how the project would affect them. Each person was encouraged to complete the comment form and to mark on the property tax maps any features or information that might have an impact on the project or their property.

Following the open house, there was a 30-day period for submission of comments. The comment period was extended by two weeks to allow for additional comments. A database was established to capture all comments received from the public. Following are actions taken and information that resulted from the evaluation of these comments.

TVA consolidated direct public input marked on property tax maps at the open house to use for the next phase of transmission line route adjustments and substation site area evaluations. Some examples of useful information received at the open house were the location of future subdivisions, water wells, outbuildings, cave systems, private airstrips, and cemeteries. These were factored in the analysis of and adjustment to the proposed route segments that were shown at the open house.

As a result of public input, four more potential substation sites were added to the scope of the project; these sites are identified as Sites 5-8 in Figure 2-6. One of the new substation sites was an existing abandoned industrial site pointed out by meeting attendees, and the other three were identified by landowners who were willing to sell property to TVA for the substation.

Site 5 is located on Rocky Glade Road about 2 miles southeast of Site 3 in the Pleasant Hill Community. The site is primarily wooded with some scattered clearings. The site has been heavily browsed by goats and is primarily level, but with several rock outcrops and at least one sinkhole or cave. Three houses are near the site bordering on the south and one house is adjacent to the east. The transmission line connections would be the longest for any of the 8 sites that were identified.

Site 6 is located on Coleman Hill Road about 7000 feet west of site 2 and about 1000 feet north of the road. The site is heavily wooded and has substantial slopes. The site is dominated by karst terrain with at least one cave and several sinkholes present. There were no nearby houses or other development. The existing access road would require major improvement to allow access to the site. The transmission line connections would be the shortest of any of the identified sites.

Site 7 is located off Patterson-Windrow Road about mile west of its intersection with Coleman Hill Road. The site is also heavily wooded and has substantial slopes and a large drainage area running south to north across the eastern third of the site. The site is exhibits some karst terrain. There were no nearby houses or other development. The existing access road would require major grading and leveling to allow equipment access to the site. The transmission line connections would be longer than those of sites 1, 2 or 6, but shorter than those for the remaining identified sites.

Site 8 is located on US 31 about 2500 feet south of the US 41A/31A intersection. The site is a former industrial site immediately adjacent to the Harpeth River that was operated by General Smelting & Refining Inc. A lead recycling plant operated at this location and the site is posted as containing hazardous waste and signs indicated that the Harpeth River at this site could be contaminated by high level of lead. Site use could require removal of some of the on site industrial buildings. Homes located to the east and south of the site would constitute significant siting constraints for transmission line connections.

At the conclusion of the extended comment period and after making appropriate adjustments to the segments based on knowledge gained during that time, TVA developed transmission line routes that utilized existing vacant, TVA-owned ROW and new ROW easements.

2.6. Identification of Preferred Substation Site and Transmission Line Routes

2.6.1. Preferred Substation Site

At the end of the public comment period, TVA began the process of narrowing the proposed substation sites to a preferred substation site. This was accomplished by assessing all eight of the proposed substation sites using a series of evaluations that began with placing all eight substation site areas on a constraint map for general location. An evaluation team then visited each proposed site area for field investigation. Direct access was not possible for Site 3.

This team was made up of experts in a variety of fields including:

- Environmental Engineer
- Botanist
- Wildlife Biologist
- Aquatic Life Biologist
- Wetland Biologist
- Landscape Architect
- Archaeologist
- Civil Engineers – Substation Physical Design
- Civil Engineers – Siting

Each member of the team evaluated each site based on his/her field of expertise. The team members submitted their conclusions. TVA then compiled and analyzed the information (Appendix D - Table D-1), and the site areas listed below were eliminated for the reasons that follow:

Site 2

- *Engineering and Construction Criteria*

  On site reviews showed that the original area identified as Site 2 was poorly drained and its hydric soil characteristics would result in significant construction problems.

- *Ecological Criteria*

  The same issue discussed above could result in environmental problems related to erosion control and sedimentation.

Site 3

- *Engineering and Construction Criteria*
  - Site acreage was poor for storage of construction materials and equipment. This would impede property owner farming operation.
  - Site drainage was poor. TVA would have to reroute a drainage ditch that currently runs through the middle of the proposed substation site area.

- *Ecological Criteria*
  - Close to aquatic resources; a channelized conveyance bisects the property.
  - The presence of threatened and endangered species and/or sensitive habitats were likely in the form of cedar glades.
  - The impact on prime farmland could be significant.

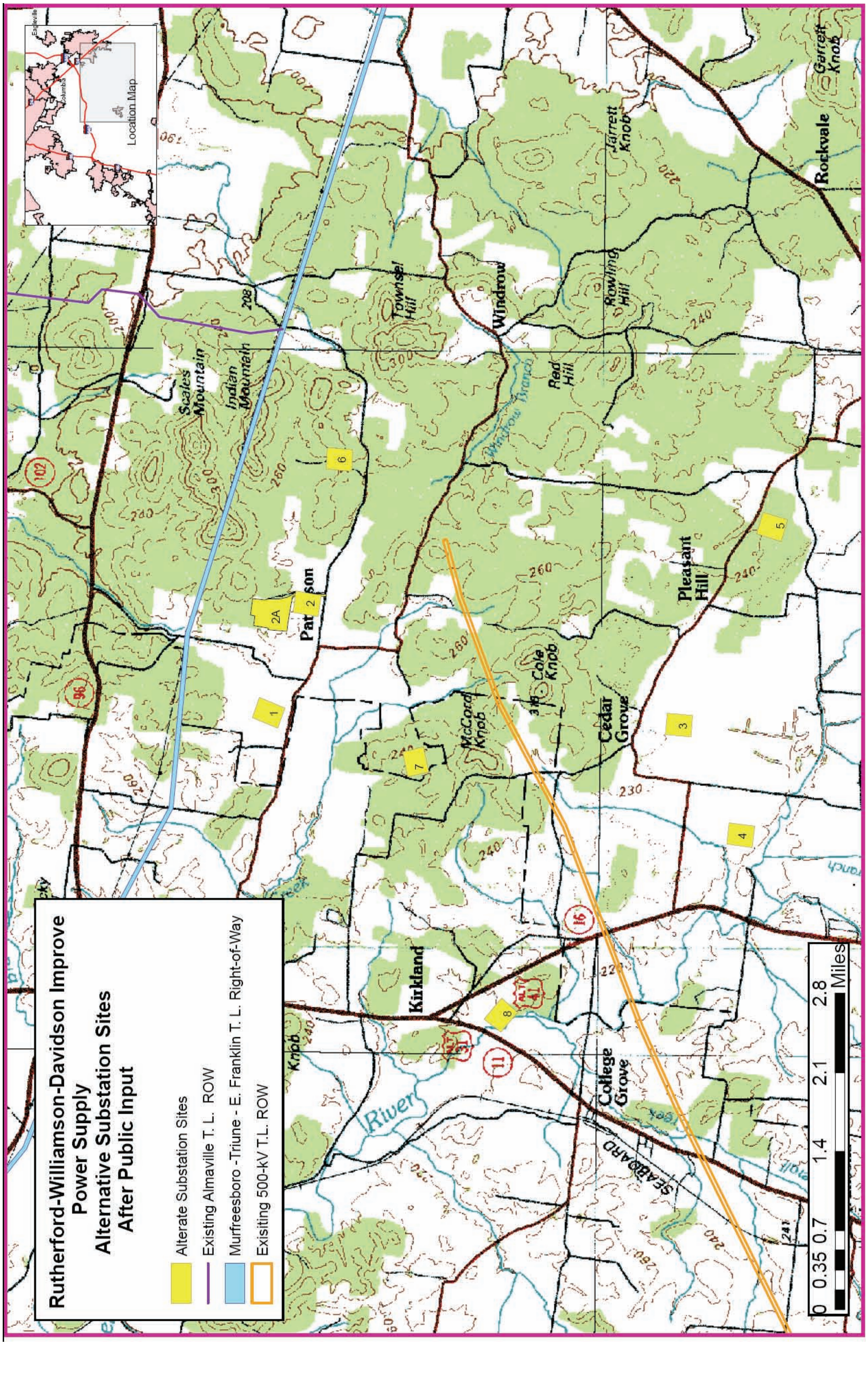

Figure 2-6. The Original Four Proposed Substation Site Locations and Additional Potential Sites Provided by the Public

Site 5

- *Engineering and Construction Criteria*

  Soil is very limited for bearing pressures for foundations due to the high fractured rock content of the site.

- *Land Use Criteria*

  The site would have to occupy several tracts of land that would impact a larger number of property owners.

- *Line Length Criteria*

  It has the longest line lengths, which would increase cost, would affect the greatest number of property owners, and would have the most significant transmission line related environmental impacts.

Site 6

- *Engineering and Construction Criteria*
  - The site has significant slopes and karst terrain, which would create grading problems.
  - There would have to be extensive clearing for the substation site.
  - High site preparation cost due to a large amount of earthwork that would be needed.
  - There were a number of sinkholes on the proposed substation site area that could be the indication of a cave.

- *Ecological Criteria*

  Field investigations identified a cave on the proposed substation site area.

- *Cultural and Land Use Criteria*

  The substation site area would cover land of approximately four to five property owners.

Site 7

- *Engineering and Construction Criteria*
  - Excessive slopes for a substation site.
  - The distance from paved road to the site was excessive and would cause problems for heavy equipment to negotiate.
  - There was a drainage area running through the middle of the site that would have to be relocated.
  - Excessive site preparation; heavily forested and large quantities of cut and fill.

- *Ecological Criteria*
  - Clearing of heavily forested terrain would impact terrestrial species and ecology.
  - Relocation of the drainage on site could have ecological consequences.

Site 8

- *Engineering and Construction Criteria*

  This site was unacceptable because the previous industry's processes had contaminated the site. It is now considered a hazardous materials site and, as such, is considered outside the scope of work and funds necessary to do the environmental cleanup to make it a viable alternative. In addition, the distance of the proposed substation in relation to the Harpeth River is not conducive for constructing a substation.

After the field investigation only Substation Site Areas 1 and 4 were still considered viable. However, additional investigations on the property that contained Site 2 and discussions with the landowner resulted in the identification of Site 2A, an alternate location north of Site 2. This 53.1-acre site appeared to be suitable from both an engineering and ecological standpoint (Figure 2-6). Because Sites 5 through 8 were not considered viable, transmission line routes were not developed to these sites. Site 2A would utilize the same transmission line routes that were possible for Site 2 (Table 2-1).

2.6.2. Ranking of Preferred Substation Site and Route Alternatives

The 3 alternative substation site areas that were still considered viable and their 34 associated transmission line route alternatives (Table 2-2) were evaluated on the basis of a range of criteria comprising four broad areas: potential for impacts to land use, potential impacts to cultural features, potential impacts to ecological features, and engineering/construction attributes. Economic issues, especially those related to project costs, are directly and indirectly incorporated into this evaluation. The raw numbers used in these ratings, a combination of quantitative measurements and subjective scores, were converted to numerical scores using standard statistical methods.

Table 2-2. Alternative Transmission Line Routes in Connection With the Three Proposed Substation Sites Considered to be Viable Alternative Sites After the Site Visits

Route	Segment Composition	Substation Site
1	1, 2, 4, 7, 10, 12	2A
2	1, 2, 4, 7, 10, 11, 12	2A
3	1, 2, 5, 6, 7, 8, 10, 12	2A
4	1, 2, 5, 6, 7, 8, 10, 11, 12	2A
5	1, 3, 6, 7, 8, 10, 12	2A
6	1, 3, 6, 7, 8, 10, 11, 12	2A
7	1, 2, 4, 7, 14, 15, 16, 17, 18	1
8	1, 2, 4, 7, 11, 14, 15, 16, 17, 18	1
11	1, 2, 5, 6, 7, 8, 14, 15, 16, 17, 18	1
12	1, 2, 5, 6, 7, 8, 11, 14, 15, 16, 17, 18	1
13	1, 2, 5, 6, 7, 8, 14, 16, 17, 18	1
14	1, 2, 5, 6, 7, 8, 11, 14, 16, 17, 18	1
15	1, 3, 6, 7, 8, 14, 16, 17, 18	1
16	1, 3, 6, 7, 8, 11, 14, 15, 16, 17, 18	1
39	1, 2, 4, 7, 14, 15, 18, 20, 21, 24, 25, 26	4
40	1, 2, 4, 7, 14, 15, 18, 20, 21, 24, 25, 26	4
41	1, 2, 4, 7, 14, 15, 18, 20, 21, 24, 25, 26, 27	4
42	1, 2, 4, 7, 14, 15, 18, 20, 21, 24, 25, 26, 27	4

Route	Segment Composition	Substation Site
43	1, 2, 5, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26	4
44	1, 2, 5, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26	4
45	1, 2, 5, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26, 27	4
46	1, 2, 5, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26, 27	4
47	1, 3, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26	4
48	1, 3, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26	4
49	1, 3, 6, 7, 8, 14, 15, 18, 20, 21, 24, 25, 26, 27	4
51	1, 2, 5, 6, 9, 14, 15, 23, 25, 26	4
52	1, 2, 5, 6, 9, 14, 15, 23, 25, 26	4
53	1, 2, 5, 6, 9, 14, 15, 23, 25, 26, 27	4
55	1, 3, 6, 9, 14, 15, 23, 25, 26	4
56	1, 3, 6, 9, 14, 15, 23, 25, 26	4
57	1, 3, 6, 9, 14, 15, 23, 25, 26, 27	4
58	1, 3, 6, 9, 14, 15, 23, 25, 26, 27	4
59	1, 3, 6, 9, 23, 25, 26	4
60	1, 3, 6, 9, 19, 21, 23, 24, 25, 26	4

Of the three substation sites, Site 2A ranked as the best with a score of 107 (Appendix D - Table D-1). Site 4 ranked second with a score of 131, and Site 1 ranked last with a score of 148 (Appendix D - Table D-1).

Using the 27 originally defined transmission line segments (Figure 2-5), eight transmission line route alternatives were possible with the use of Substation Site 1, six with Substation Site 2A, and 20 with Substation Site 4 (Table 2-2). The overall scores for each of these routes were then computed, and the alternative transmission line routes were ranked by overall desirability (Appendix D - Table D-2). Three of the top five scoring combination of transmission line routes utilized Substation Site 2A.

The results of this analysis were that Site 2A was identified as the best scoring substation site and Route 5 was the best scoring combination of transmission line routes. Route 5 was a segment combination that connected to Site 2A.

2.6.3. Preferred Substation Site and Transmission Line Routes

TVA’s preferred substation site is a modified version of Alternative Site 2 (Site 2A). This site, located on Coleman Hill Road about 4 miles east of US 31A/41A, would be 53.1 acres in size with approximately 40 graded acres included within the fenced area (Figure 1-2).

After the preferred transmission line routes were identified, affected property owners were mailed information showing the location of the preferred routes on their property. Additional comments received from property owners were reviewed, and where practical, changes were made to the preferred route selections prior to engineering and environmental field surveys. After property owners reviewed the changes, the sections were resurveyed to identify the final routes. Additionally, the substation site boundaries were adjusted to take advantage of land more suitable for construction of the substation. This adjustment also made the substation less visible to the surrounding community.

The preferred transmission line routes connecting the substation would include modified versions of Segments 1, 3, 6, 7, 8, 10, and 12. ROW widths for the proposed transmission lines would vary depending on the type of transmission line and how many lines would be with the ROW (Table 2-3). The initial 1.2 miles of transmission line from the Rutherford Substation site to the existing 500-kV ROW would include the Christiana 161-kV Transmission Lines plus space for one additional 500-kV transmission line circuit, if needed in the future. For the purposes of this document, to avoid repetition of the evaluation of this portion of ROW this section will be included with the Rutherford-Christiana 161-kV Transmission Line.

Table 2-3. Right-of-Way Widths for the Proposed Transmission Line Sections

Transmission Line ROW Section	ROW Width (feet)
Rutherford-Maury 500-kV Transmission Line (existing ROW)	175
Rutherford-Maury 500-kV Transmission Line ROW shared with Rutherford-Christiana Transmission Line (new ROW)	425
Rutherford-Christiana Transmission Line (new ROW)	100
Rutherford-Murfreesboro-Triune-East Franklin Transmission Line; Shared with Rutherford-Almaville Transmission Line (new ROW)	275
Rutherford-Almaville Transmission Line (new ROW) Parallel to existing Murfreesboro-Triune-East Franklin Transmission Line	87.5
Rutherford-Almaville Transmission Line (existing ROW)	100

Preferred transmission line routes associated with Site 2A would include:

- Approximately 27 miles of 500-kV transmission line on vacant, TVA-owned ROW. For the purposes of this document, this Rutherford-Maury 500-kV Transmission Line will be referred to as the Maury 500-kV Transmission Line.
- Approximately 6 miles of new 161-kV transmission line on vacant, TVA-owned ROW from the Rutherford Substation to the Almaville Substation. For the purposes of this document, this Rutherford-Almaville 161-kV Transmission Line will be referred to as the Almaville 161-kV Transmission Line.
- Approximately 3 miles of new 161-kV transmission line from the Rutherford Substation to the existing Almaville Transmission Line ROW. This route consists of transmission line Segment 12 plus a portion parallel to the existing Murfreesboro-Triune-East Franklin 161-kV Transmission Line. For the purposes of this document, to avoid repetition this portion of parallel ROW will be referred to and evaluated as part of the Almaville 161-kV Transmission Line.
- Approximately 15 miles of new double-circuit, 161-kV transmission line from the Rutherford Substation site to the Christiana Substation. For the purposes of this document, this Rutherford-Christiana 161-kV Transmission Line will be referred to as the Christiana 161-kV Transmission Line.

The alternative substation site (Site 2A) and transmission line route segments were adjusted based on public and property owner input as well as environmental data to lessen overall impacts. Examples include following parcel boundaries, to lessen the impact on future uses of the property and to reduce proximity to cultural/historical features and sensitive species.

2.7. Description of Construction, Operation, and Maintenance of the 500-kV Substation, and 500- and 161-kV Transmission Lines

2.7.1. Substation Property Acquisition, Clearing, and Construction

Property for the proposed 500-kV substation at the identified preferred location and an access road about 1,500 feet in length would be purchased from landowners. The amount of land needed for the construction of the substation would be about 53 acres depending on final design, site soil conditions, and negotiations with the landowners.

TVA would clear vegetation, remove topsoil, and grade approximately 40 acres of the property in accordance with TVA's *Site Clearing and Grading Specifications* (Appendix E). Two intermittent streams and a small farm pond that are located on the substation site would not need to be filled or rerouted around the substation property. However, if the site design were to change, TVA would acquire any necessary permits prior to this action (i.e., ARAP, 404). Once the substation site has been graded, spoil would be removed in preparation for foundations. The topsoil and spoil stored in separate piles would be reused on the property for restoration. Gravel would be placed on the substation site and access road. The substation would be fenced with chain-link security fencing. Major equipment would include 500-161-kV transformers, several circuit breakers, connecting bus work, a supporting steel superstructure, ground wire towers, switch house, and equipment storage building. Oil containment consisting of concrete basins around oil-filled equipment and piping would be installed for the 500-161-26-kV transformer bank, and a retention pond or tank would be constructed on the property. The oil/water separator used at the site would allow the water to drain as runoff. If the oil should build up, the oil would then be pumped and hauled to an approved waste receiving facility. The circuit breakers installed would utilize SF-6 as the electrical insulator and would contain no oil. The switch house would be equipped with water and septic tank drain field. A water line would be installed along the substation access road and connected to the local water supply system. A field line system would be installed to treat the generated sewage. A 250-foot microwave tower would be erected within the substation site. The tower would have a strobe light flashing red at night and flashing white during the day. The lighting for the substation would be designed to minimize light pollution while still meeting safety and security requirements. An aerial view of a typical TVA 500-kV substation is shown in Figure 2-7.

2.7.2. Transmission Line Construction

2.7.2.1. Right-of-Way Acquisition and Clearing

Most of the existing 500-kV transmission line ROW from the Maury 500-kV Substation is 175 feet in width. From this existing ROW to the proposed Rutherford Substation site, an additional 2 miles of ROW would need to be 425 feet wide (approximately 10 acres) to accommodate parallel lower voltage lines connecting to the new substation and possible future connections. Most new 161-kV transmission line ROW would be 100 feet wide; however, some ROWs near the 500-kV substation may accommodate additional future transmission lines, if needed.

Figure 2-7. Aerial View of Typical 500-kV Substation

TVA would purchase easements from landowners for approximately 308 acres of new ROWs on private land. These easements would give TVA the right to construct, operate, and maintain the transmission line, as well as remove danger trees off the ROW. Danger trees are those trees that are located away from the cleared ROW, but are tall enough to pass within 10 feet of a conductor or strike a structure should it fall toward the transmission line. Fee title, i.e., ownership, for the land within the ROW remains with the landowner, and a number of activities may be continued on the property by the landowner. However, the easement agreement prohibits certain activities such as the construction of buildings and any other activities within the ROWs that could interfere with the transmission line or create a hazardous situation.

Because of the need to maintain adequate clearance between tall vegetation and transmission line conductors, as well as to provide access for construction equipment, most trees and shrubs would be initially removed from the entire width of the ROWs. Equipment used during this ROW clearing would include chain saws, skidders, bulldozers, tractors, and/or low ground-pressure feller-bunchers. Marketable timber would be salvaged where feasible; otherwise, woody debris and other vegetation would be piled and burned, chipped, or taken off site. In some instances, vegetation may be windrowed along the edge of the ROWs to serve as sediment barriers.

Streamside management zones (SMZs) would be established along intermittent and perennial streams; their width would be based on stream characteristics, slope, soil types, and other factors (Muncy 1999). Vegetation removal in SMZs and wetlands would be restricted to trees tall enough, or with the short-term potential to grow tall enough, to interfere with conductors. In rugged terrain, vegetation at the bottom of ravines would be left if there is adequate clearance between it and the conductors. Clearing in SMZs would be accomplished using hand-held equipment or remote-handling equipment, such as a feller-buncher, in order to limit ground disturbance. TVA's *Right-of-Way Clearing Specifications*; *Environmental Quality Protection Specifications for Transmission Line, Substation, or Communications Construction*; and *Transmission Construction Guidelines Near Streams* (Appendices F, G, and H) would be followed in clearing and construction activities.

Subsequent to clearing and construction, vegetative cover on the ROWs would be restored as much as is possible to its state prior to construction. Pasture areas would be reseeded with suitable grasses. Wooded areas would be restored using native grasses and other low-growing species. Erosion controls would remain in place until the plant communities become fully established. Streamside areas would be revegetated as described in Appendices F through H.

2.7.2.2. Access Roads

Temporary access roads would be needed to allow vehicle access to each structure and other points along the ROWs. TVA would obtain the necessary permission to use these access roads from landowners. Existing roads, some of which may need upgrading, would be used where possible. New access roads would be located on the ROWs, wherever possible, and designed to avoid severe slope conditions and minimize stream crossings. New access roads would be about 18 feet wide and surfaced with dirt or gravel. Culverts and other drainage devices, fences, and gates would be installed as necessary. New access roads would be planted with approved seed mixtures following construction.

The actual locations of access roads cannot be determined until both the preferred transmission line route and the specific alignment are chosen and the individual structure locations are then identified. Once these access roads are identified, environmental field surveys will be conducted and these roads will be described in the Final EIS.

2.7.2.3. Construction Assembly Areas

Construction assembly areas (laydown areas) would be required for worker assembly, vehicle parking, and material storage. They are typically 5 to 10 acres in size, relatively flat, previously cleared, and located adjacent to an existing paved road near the transmission line. These areas are usually leased from a private landowner for the duration of the construction period. Depending on site conditions, some grading and installation of drainage structures may be required. The areas would be graveled and fenced, and trailers, used for material storage and office space, would be parked on the areas. TVA's *Site Clearing and Grading Specifications* (Appendix E) would be followed in clearing and construction activities. Following the completion of construction activities, all trailers, unused materials, and construction debris would be removed from the site. Removal of the fence and restoration would be at the discretion of the landowner.

A separate construction assembly area is typically required for approximately every 10 miles of new transmission line. One previously evaluated assembly area that is located in the project vicinity would be used for the proposed project (TVA 2007; Figure 1-2). Once other assembly areas are identified, environmental surveys will be conducted and these assembly areas will be described in the Final EIS.

2.7.2.4. 500-kV Structures and Conductors

The proposed 500-kV transmission line would use self-supporting, galvanized, laced-steel structures similar to those shown in Figures 2-8 and 2-9. The electrical conductors would consist of three sets of three, 954,000 circular mil aluminum-steel-reinforced cables bundled in a triangular configuration, suspended beneath the structure crossarms by two insulators, 14 feet long, arranged in a “V” shape. Two single ground wires would be placed on the two highest points of the structures to provide lightning protection. In some cases, these ground wires may carry fiber optic or other communication circuits. The structures may also have a second crossarm added beneath the 500-kV transmission line to support one or two lower voltage lines, allowing additional transmission lines on the same ROW. Tower height would vary with terrain and land use along the route but would normally range between 85 to 125 feet. The distance between structures would vary based on the same factors but would typically be about 1,000 feet. Tower foundations are normally a laced-steel grillage, one per leg, buried in the earth. Some towers at points where the line turns an angle would require foundations of reinforced concrete. Figure 2-8 shows a sketch of a typical structure with no underbuilt transmission lines. Figure 2-9 shows a sketch of a typical structure with two underbuilt lower voltage transmission lines.

Structures that support long spans, such as at an interstate highway, would be substantially taller than typical to maintain required clearance beneath the conductors. If any towers exceed 200 feet height aboveground, these would require lighting under Federal Aviation Administration regulations. This lighting would either be a white strobe light flashing at all times or a combination of the strobe light during daylight hours and a constant red light at night. Aircraft warning spheres would be placed on the highest wires (ground wires) at river and interstate crossings and at any other locations where aviation patterns require them.

After clearing, construction would generally progress in the following order:

- Excavation of foundation or grillage holes
- Installation of the foundations and grillages
- Assembly, on the ground, of large portions of the steel structures
- Placement of the assembled structures on the foundations using cranes
- Hanging of insulators with “pulling blocks” or pulleys attached to allow the new conductors and ground wires to be pulled through
- Pulling the ground wires and conductors into place
- “Sagging” the conductor; that is, adjusting it to the proper tension and height to meet the required clearances
- Clipping the conductor into place on the end of the insulators
- Inspection and testing of the line
- ROW restoration and clean up

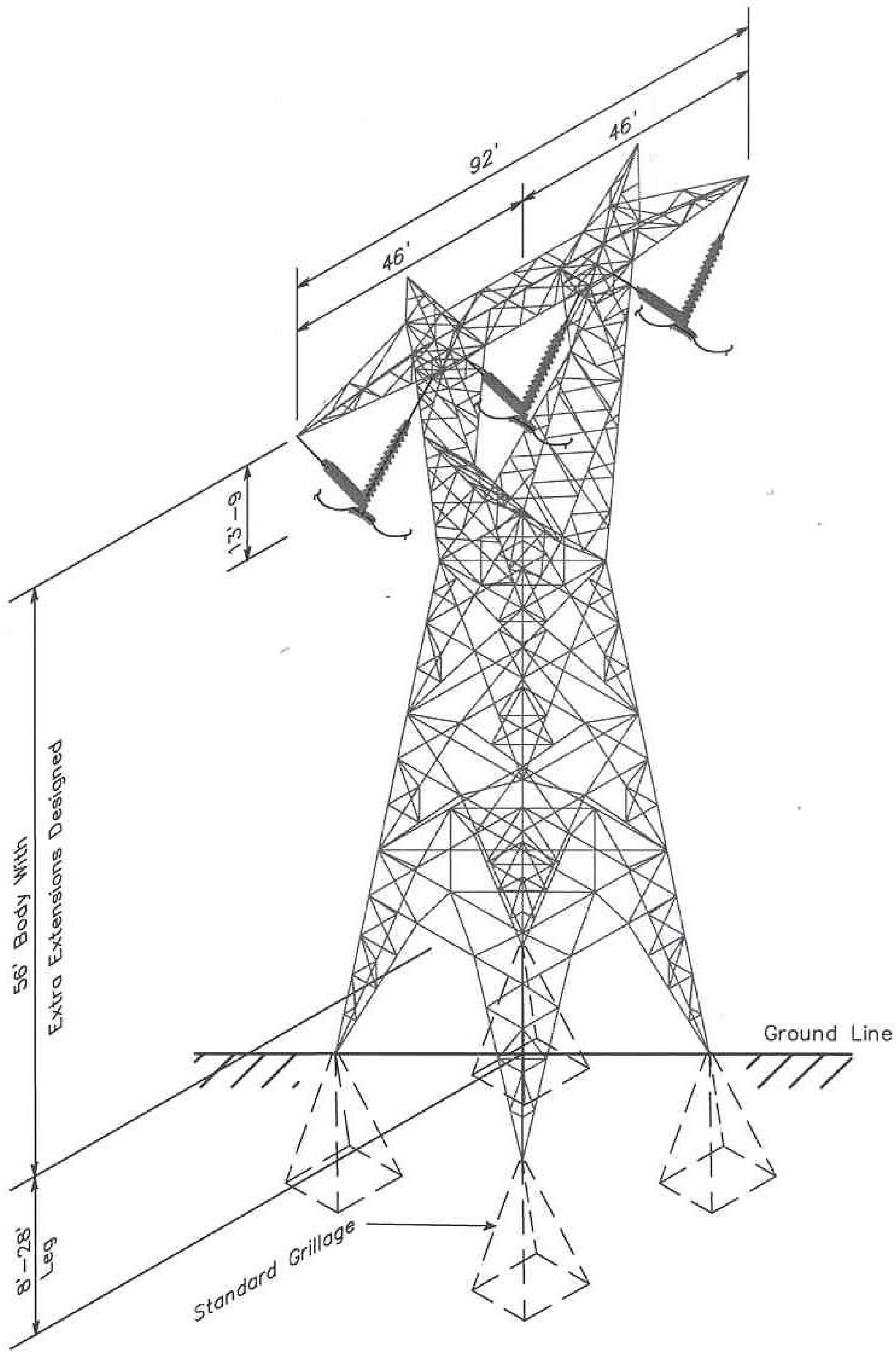

Figure 2-8. Typical 500-kV Transmission Line Structure

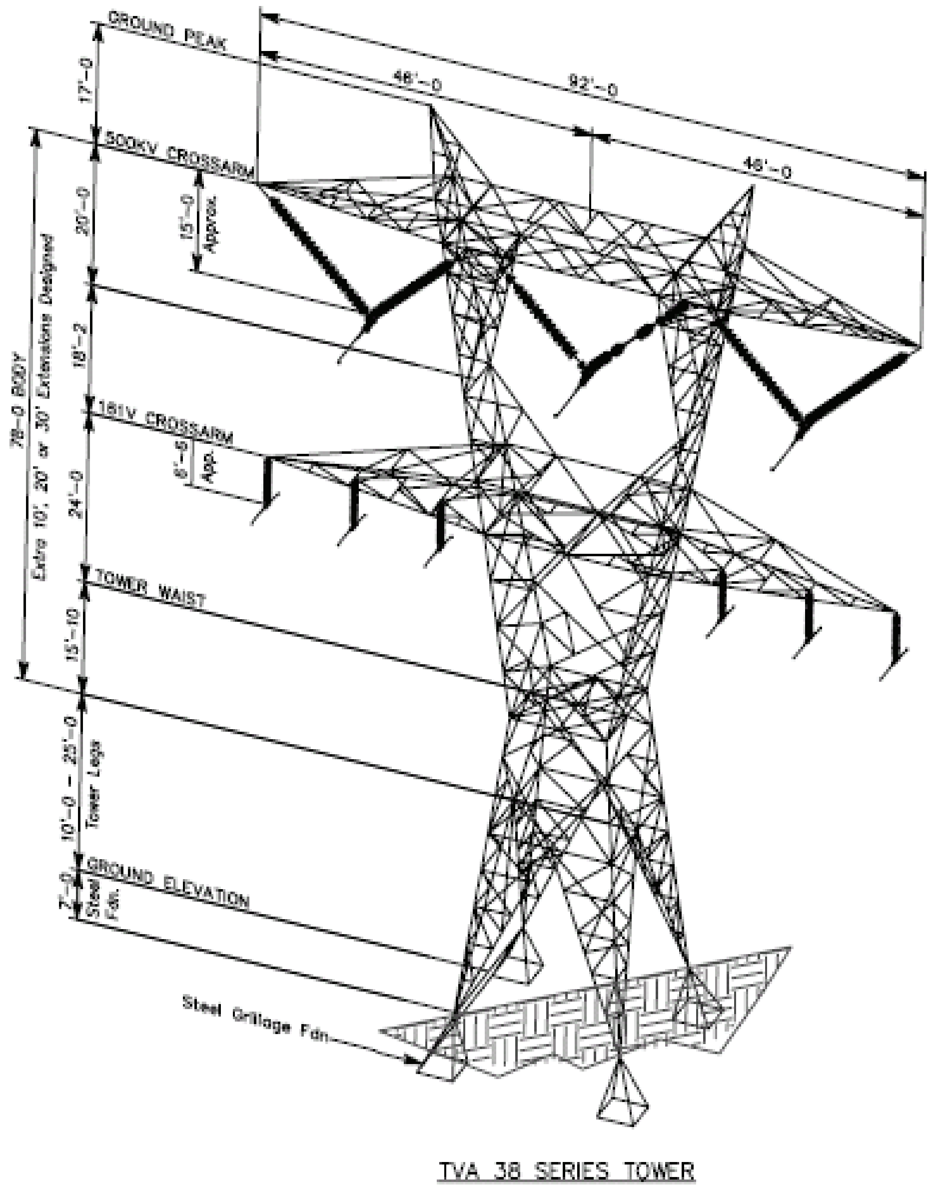

Figure 2-9. Typical 500-kV Transmission Line Structure With Two Under-Built Transmission Lines

After the transmission line is constructed, the ROW would be revegetated using native, low-growing plant species in appropriate areas. Areas such as pasture, agricultural fields, or lawns would be returned to their former condition. Additional applicable environmental quality protection specifications that would be used during ROW clearing and transmission line construction are listed in Appendices E and G and in Muncy (1999).

The transmission line ROW can be used by the landowner for many purposes; however, the construction of permanent buildings, trees that reach the height of the electrical conductors, and storage of any flammable material would be prohibited.

2.7.2.5. 161-kV Structures and Conductors

The proposed 161-kV transmission lines would be built using either single steel-pole structures or H-frame steel-pole structures (Figures 2-10 and 2-11). Structure type and heights would vary according to the terrain and would range between 80 and 110 feet.

Three conductors (the cables that carry the electrical current) are required to make up a circuit (transmission line) in alternating current transmission lines. For 161-kV transmission lines, each conductor is made up of a single cable. The conductors are attached to fiberglass or ceramic insulators suspended from the structure crossarms. A smaller overhead ground wire(s) is attached to the top of the structures. This ground wire may contain fiber optic communication cables.

Poles at angles in the transmission line may require supporting guy wires. Some structures for larger angles could require two or three poles. Most poles would be imbedded directly in holes augured into the ground to a depth equal to 10 percent of the pole’s length plus an additional 2 feet. The holes would normally be backfilled with the excavated material. In some cases, gravel or a cement and gravel mixture might be necessary. Some structures may be self-supporting (non-guyed) poles fastened to a concrete foundation that is formed and poured into an excavated hole.

Figure 2-10. Single-Pole 161-kV Transmission Structure

Figure 2-11. Double-Circuit Transmission Line, H-Frame 161-kV Transmission Structure

Equipment used during the construction phase would include trucks, truck-mounted augers, and drills, as well as tracked cranes and bulldozers. Low ground-pressure-type equipment would be used in specified locations (e.g., areas with soft ground) to reduce the potential for environmental impacts.

2.7.2.6. Conductor and Ground Wire Installation

Reels of conductor and ground wire would be delivered to various staging areas along the ROW. Prior to installing the conductors, temporary clearance poles would be installed at road and railroad crossings to reduce interference with traffic. Installation of conductors would begin with a small rope being pulled from structure to structure. This rope would then be connected to the conductor and ground wire and used to pull them down the line through pulleys suspended from the insulators mounted on the structures. Specialized tensioning equipment would be used to pull conductors and ground wires to the proper tension. Finally, the wires would be clamped to the insulators and the pulleys removed. In some areas where access is difficult, a helicopter may be used for various tasks including moving of material and personnel, pulling conductor pull-ropes, or installation of conductor spacers.

2.7.3. Operation and Maintenance

2.7.3.1. Inspection

Periodic inspections of TVA's transmission lines are performed by aerial surveillance, using a helicopter, at six-month intervals and by ground observation every one to two years. These inspections are conducted to locate damaged conductors, insulators, or structures, and to report any abnormal conditions that might hamper the normal operation of the line or adversely impact the surrounding area. During these inspections, the condition of vegetation within the ROW, as well as immediately adjoining the ROW, is noted. These observations are then used to plan corrective maintenance or routine vegetation management.

2.7.3.2. Vegetation Management

Management of vegetation along the ROWs would be necessary to ensure access to structures and to maintain an adequate distance between transmission line conductors and vegetation. This vegetation management along the ROW would consist of two different activities: the felling of danger trees adjacent to the cleared ROW, as described in Section 2.7.2.1, and the control of vegetation within the cleared ROW. To accomplish this, TVA would use an integrated vegetation management approach designed to encourage low-growing plant species and discourage tall-growing plant species.

A vegetation reclearing plan would be developed for each transmission line segment based on the results of the periodic inspections described above. The two principal management techniques are mechanical mowing, using tractor-mounted rotary mowers, and herbicide application. Herbicides would be selectively applied from the ground with backpack sprayers or vehicle-mounted sprayers, or, for larger areas, particularly in rugged terrain, by broadcast aerial spraying.

Any herbicides used would be applied in accordance with applicable state and federal laws and regulations as well as the specific commitments contained in this document. Only herbicides registered with the U.S. Environmental Protection Agency (USEPA) would be used. A complete list of the herbicides currently used by TVA in ROW management is included in Appendix I. This list may change over time as new herbicides are developed or new information on presently approved herbicides becomes available.

2.8. Comparison of Alternatives

Table 2-4 compares the environmental impacts of the two proposed alternatives derived from the information and analysis provided in Chapter 3, Affected Environment and Chapter 4, Environmental Consequences.

Table 2-4. Comparison of Alternatives Table

Resource Area	Alternative 1 The No Action Alternative	Alternative 2 The Action Alternative
Groundwater	Implementation of Alternative 1 would result in no environmental impacts to groundwater.	With the use of best management practices (BMPs) and control measures normally applied by TVA, potential effects to groundwater quality would be insignificant.
Surface Water	Under Alternative 1, no environmental impacts to surface water would occur.	Potential impacts would be minimized by avoiding stream crossings where possible and implementation of BMPs. Impacts to surface waters are expected to be insignificant.
Aquatic Ecology	Under Alternative 1, no environmental impacts to aquatic ecology would occur.	Overall impacts to aquatic ecology with implementation of protective measures are expected to be insignificant.
Vegetation	Under Alternative 1, no environmental impacts to vegetation would occur.	Implementation of Alternative 2 would result in the long-term conversion of 370 acres of forested areas to early successional habitats. Given the recent increase in forest area, this would not result in significant regional impacts. Impacts to several rare plant communities affected by the transmission lines could be minimized through implementation of mitigation measures.

Resource Area	Alternative 1 The No Action Alternative	Alternative 2 The Action Alternative
Wildlife	Under Alternative 1, no environmental impacts to wildlife would occur.	Potential impacts to wildlife would result from the long-term conversion of forest to early successional habitats and from the creation of forest-edge habitat. Significant impacts to terrestrial wildlife and their habitats are not expected, as the surrounding landscape is already highly disturbed from previous agricultural and forestry practices and from current development. Impacts to sensitive cave ecosystems would be minimized by BMPs and mitigation measures
Endangered and Threatened Species	Under Alternative 1, no environmental impacts to endangered and threatened species would occur.	Effects on federally or state-listed aquatic species would be short term and insignificant with the implementation of BMPs. A few populations of state-listed plants would be adversely affected by substation and transmission line construction. Because of the relatively large number of populations of these species in Tennessee, their viability would not be adversely affected. The proposed transmission line routes were modified during the planning process to reduce the potential impacts to federally listed plants and designated critical habitat areas. With the implementation of several mitigation measures to further reduce these potential impacts, TVA has determined that these plants would not be adversely affected, and the designated critical habitat (DCH) would not be adversely modified. In order to minimize impacts to potential habitat for the Indiana bat, TVA would implement mitigation measures on the timing of timber harvesting. With implementation of mitigation measures for the protection of caves and timber, impacts on federally and state-listed animals would be insignificant.
Wetlands	Under Alternative 1, no environmental impacts to wetlands would occur.	The proposed transmission lines would affect 3.43 acres of wetlands and convert 2.3 acres from forested to nonforested wetlands. Overall wetland impacts would be minor.
Floodplains	Under Alternative 1, no environmental impacts to floodplains would occur.	The proposed Rutherford Substation would be above the 100-year floodplain and, therefore, would not affect floodplains. Portions of the proposed transmission lines would be in floodplains, but would not adversely affect flooding or floodplain values.

Resource Area	Alternative 1 The No Action Alternative	Alternative 2 The Action Alternative
Managed Areas	Under Alternative 1, no environmental impacts to natural areas would occur.	The proposed transmission lines would affect a few state natural areas and Nationwide Rivers Inventory- (NRI) listed streams. With implementation of mitigation measures, these effects would be insignificant.
Recreation	Under Alternative 1, no environmental impacts to recreational activities would occur.	There are no developed public recreation facilities near the proposed substation and transmission line routes. Recreation in the area is informal, dispersed, and on private land. Implementation of the Action Alternative would result in insignificant effects on public recreation activities and resources.
Land Use and Prime Farmland	Under Alternative 1, no environmental impacts to land use or prime farmland would occur.	Construction of the substation would remove about 29 acres from future agricultural use; this would not be a significant impact on prime farmland, and the action complies with the Federal Farmland Protection Policy Act. Construction and operation of the transmission lines would not adversely affect normal agricultural operations. Most current land uses could continue within the transmission line ROWs although a few buildings would be removed from the ROW.
Visual Resources	Under Alternative 1, no environmental impacts to visual resources would occur.	Visual impacts as a result of substation construction would be minimal because the vegetation and topography would obscure most views. The proposed transmission lines would be visually similar to poles, towers, lines, and other industrial features seen in the landscape now. Vegetation removal for new ROW would reduce scenic integrity in areas unaltered by human development. However, implementation of the Action Alternative would not reduce scenic class by two levels or more, the threshold of significance.
Cultural Resources	Under Alternative 1, no environmental impacts to cultural resources would occur.	The Action Alternative would have adverse visual effects on two historic properties listed on the National Register of Historic Places (NRHP). TVA is presently developing a memorandum of agreement with the State Historic Preservation Officer (SHPO) and other interested parties that would prescribe treatment measures to mitigate these adverse effects. In addition, in order to avoid adverse effects to archaeological resources, the known areas would be avoided when practicable, or further surveys would be completed. No additional adverse effects are anticipated to cultural resources.

Resource Area	Alternative 1 The No Action Alternative	Alternative 2 The Action Alternative
Socioeconomics	Under Alternative 1, TVA would not be able to ensure continued service reliability and reduce the risk of disruptions. Over the long term, this could have adverse economic effects to the region through the loss of electric service.	This substation and transmission line project would have no effect on population in the area. There would be little or no change in employment of local workers. Little impact on housing is anticipated. Some local revenues would be generated during the construction period, but increase in local tax revenues generally would not be noticeable. Potential impacts to property values in the range of 5 to 10 percent are possible for properties adjacent to a transmission line. The size of the impact appears to be sensitive to distance, with little or no impact to properties not adjacent or very close. No significant adverse impacts on property values are expected.
Environmental Justice	Under Alternative 1, no environmental impacts to environmental justice would occur.	Due to the location of the proposed substation and routes and the overall small share of minority and low-income residents, no environmental justice impacts are anticipated.

2.9. Proposed Mitigation Measures

NEPA and its implementing regulations require that an EIS identify appropriate and reasonable mitigation measures for the adverse impacts potentially resulting from a proposed action. Mitigation measures are actions that could be taken to avoid, offset, reduce, or compensate for adverse impacts to the environment.

The substation and line siting processes are structured to avoid or reduce potential environmental impacts. Throughout the process of planning the substation and transmission lines, TVA has taken many steps to avoid and minimize potential environmental impacts. The Alternative 2 substation site and transmission line routes are identified as TVA's Preferred Alternative in part because of their environmental aspects. Avoidance of environmental resources such as wetlands, endangered and threatened species, and cultural resources was an important factor during the siting processes, and several changes in their locations were made for this reason. This section describes other potential mitigation measures that TVA may implement.

Under the Action Alternative, TVA would use stringent best management practices (BMPs) during all construction and maintenance activities in order to minimize erosion and sedimentation and their effects on water quality. TVA would also minimize many environmental impacts by adhering to the conditions in Appendices D, E, F, and H. TVA would also categorize affected streams and apply the corresponding protective measures as described in Appendix G.

TVA has identified mitigation measures that could be implemented during construction and maintenance of the proposed substation and associated transmission lines. Mitigation measures are actions taken to avoid, minimize, rectify, reduce, or compensate for adverse impacts to the environment.

Groundwater

- No herbicides with groundwater protection warnings would be used in the sections of the Maury Transmission Line between Double Branch and Double Branch Road, Greens Mill Road and Cornstock Road, and Cross Keys Flat to Boon Creek. No fertilizers would be used in the groundwater source protection zone from Windrow Road to the end of the Maury Transmission Line study area, and neither herbicides nor fertilizers would be used in the section of the Maury line from Windrow Road to Allisonna Road.
- No herbicides with groundwater protection warnings and no fertilizers would be used in the sections of the Almaville Transmission Line from where the ROW intersects the existing Murfreesboro-East Franklin Transmission Line north to where the Almaville Transmission Line turns to the west.
- No herbicides with groundwater protection warnings and no fertilizers would be used in the section of the Christiana Transmission Line within 500 feet of the entrance to Nanna Cave.

Vegetation

- Globally rare glade habitat areas would be marked on the transmission line and access road engineering design specification drawings that would be used during the design, construction, and maintenance activities along the transmission line.
- During the construction and maintenance of the transmission lines, TVA would avoid the areas associated with the globally rare glade habitats. Unless there is no practical alternative, structure placement and access roads would be designed strategically to avoid these areas. The glade areas would be fenced during construction to ensure further avoidance.
- Vegetation management in globally rare glade habitats would be accomplished through mechanical clearing and no herbicides would be used.
- TVA would minimize the invasion of invasive exotic plant species into areas currently free of invasive plants by revegetating disturbed sites with seed mixtures determined by TVA botanists to consist of native and/or nonnative, noninvasive plant species.

Wildlife

- No herbicide spraying or mechanical clearing would occur within a 500-foot radius of the entrance to Nanna Cave during the construction and maintenance of the transmission lines to avoid impacts caused by pollution from chemicals and sedimentation from disturbed soil. This area would be hand cleared only (chainsaws may be used, but not heavy equipment). All vehicles and heavy equipment would be restricted from the area unless confined to existing access roads.

Endangered and Threatened Species

- Areas with state-listed plant species would be included in the transmission line and access road engineering design specification drawings used during the design, construction, and maintenance of the transmission line. During construction and maintenance, TVA would avoid the areas occupied by the state-listed plants. Unless there is no practical alternative, structures would be placed to avoid impacting these areas. Additionally, unless there is no practical alternative, access roads and the associated vehicle traffic would be excluded from these areas. These areas would be fenced during construction. Vegetation management in these areas would be accomplished through mechanical clearing, and no herbicides would be applied in them.

- The location of the toothache tree population would be included on the engineering design specification drawings for use during the design, construction, and maintenance of the transmission line. TVA would clear the ROW between November and March when the plant is dormant; shear-clearing (bulldozing) methods would not be used. Vegetation management in the area would be accomplished by mechanical clearing (e.g., mowing). Herbicides would not be used in this area.
- The location of the Alabama snow-wreath population would be included on the engineering design specification drawings for use during the design, construction, and maintenance of the transmission line. All construction occurring within 200 feet of the Alabama snow-wreath population would be strictly confined to the ROW. In addition, fencing would be erected along the edge of the ROW during construction to ensure impacts to Alabama snow-wreath are avoided. Vegetation management within 200 feet of the snow-wreath population would be accomplished by mechanical clearing, and herbicides would not be used.
- Information regarding the location of Pyne's ground-plum would be included on the engineering design specification drawings for use during the design, construction, and maintenance of the transmission line. Vehicles, construction equipment, and unnecessary personnel would strictly be prohibited from disturbing the population. This would be accomplished by explicitly instructing construction crews to remain on the ROW and to avoid any activity (felling trees, grading, inadvertently accessing the site with vehicles, etc.) that would alter the habitat in the immediate vicinity of the population. In addition, fencing would be erected along the edge of the ROW during construction to ensure impacts to Pyne's ground-plum are avoided. Vegetation management within 500 feet of the ground-plum population would be accomplished by mechanical clearing; herbicides would not be used.
- Prior to the transmission line construction clearing, TVA would treat all tree-of-heaven along the proposed ROW to reduce the risk of spreading within the designated critical habitat. This would be accomplished by using a basal bark application method with Garlon® 4 herbicide. The tank mixture would consist of a 20 percent Garlon® 4/80 percent carrier solution; the solution would be a specially formulated vegetable oil. Using a backpack sprayer, herbicide would be applied to the trunk of each tree-of-heaven stem from ground level to 18 inches high. All areas of the trunk in this band would be thoroughly wetted with herbicide. Herbicide does not need to be sprayed on the foliage of tree-of-heaven stems. Basal bark application would occur before trees are cleared from the proposed ROW between the months of February 15 to April 15 or June 1 to September 1.
- Timber harvesting for ROW clearing in six areas of moderately suitable habitat for the Indiana bat would take place between October 15 and March 31.

Cultural Resources

- In order to avoid adverse effects to archaeological site 40WM35, TVA would not place transmission line structures within the site or cause other ground disturbance of the site. If impacts to the site cannot be avoided in this manner, TVA would conduct further Phase II archaeological testing to identify locations for structure placement that would not adversely affect the site.
- Archaeological sites 40RD280 and 40RD281 would be avoided by the rerouting of a section of the Christiana Transmission Line.

- TVA would implement the treatment measures necessary to mitigate adverse effects on two historic sites, the William Allison house and the Smithson-McCall farm. These measures will be described in a memorandum of agreement being developed between TVA, the Tennessee State Historical Preservation Office, and other interested parties.